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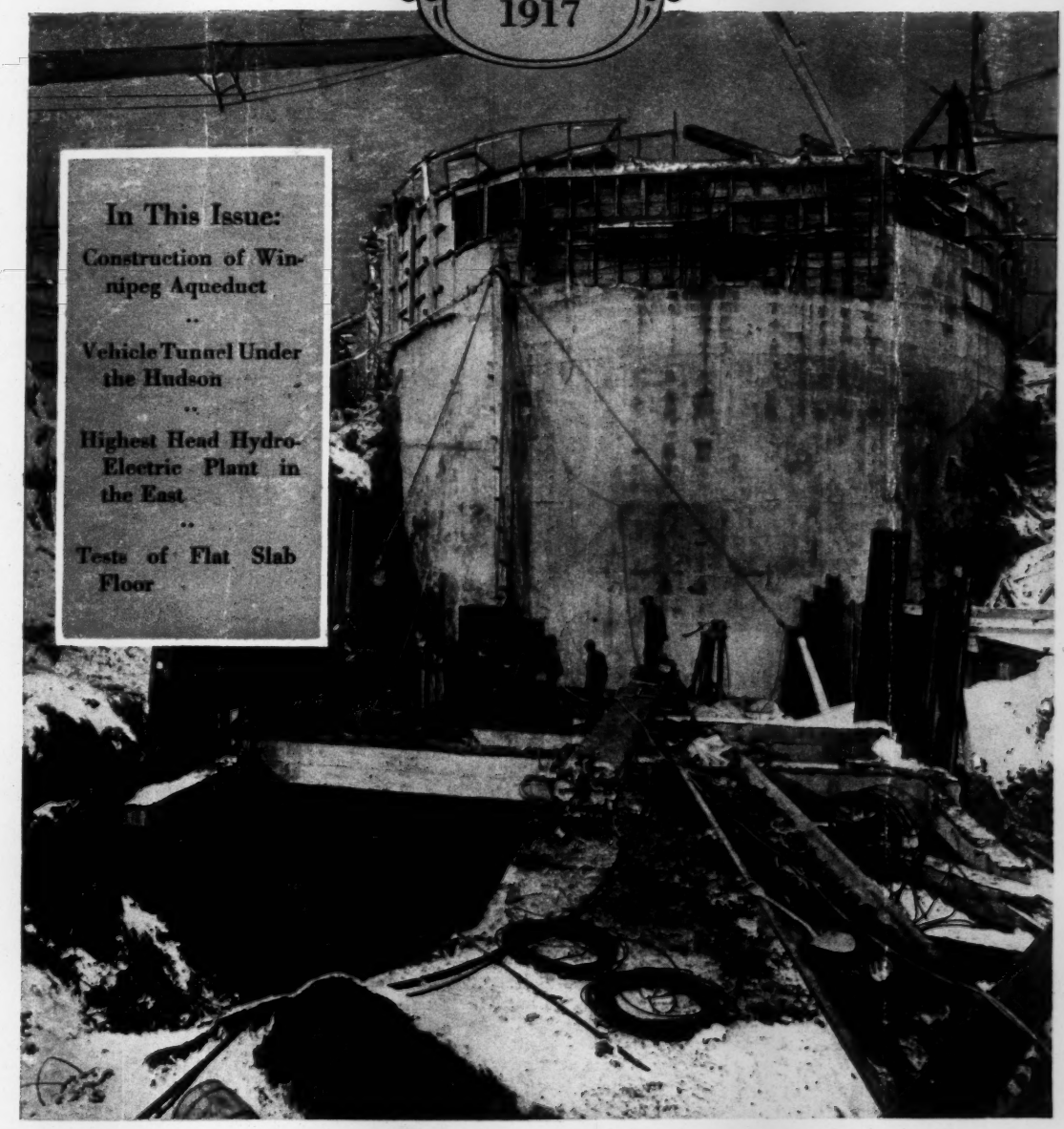

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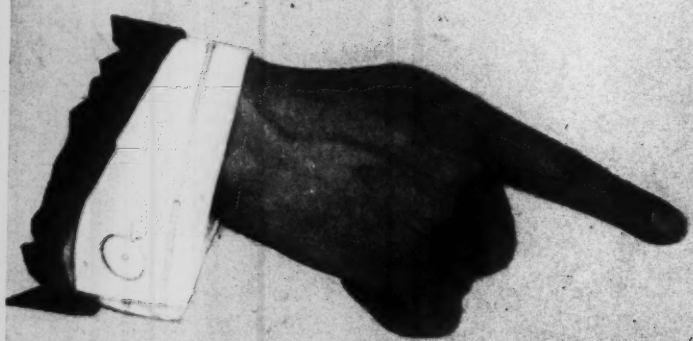

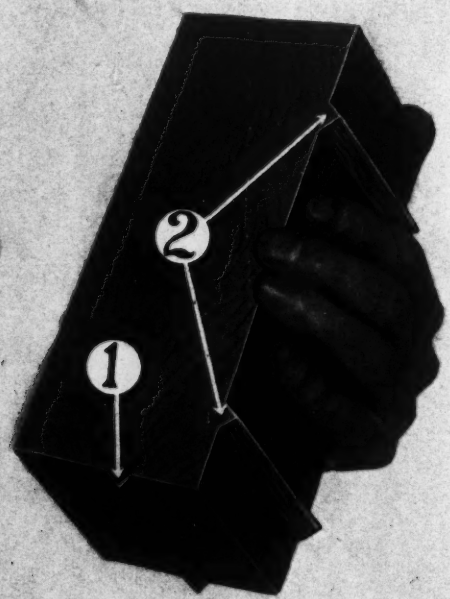

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Pitchforks, Centrifugal Pumps and 160-Ton Draglines Dig Aqueduct Ditch Through Muskeg Bogs

Part I—Construction of Winnipeg Conduit Proves Value of Advance Drainage To Permit Use of Heavy Excavating Tools in Swamps

By WILLIAM SMAILL

Superintendent, Winnipeg Aqueduct Construction Company, Limited, Winnipeg, Man

IN EXCAVATING 48 miles of cut for the eastern end of the new Winnipeg Aqueduct, dragline machines of varying sizes, designed for work in the swampy and almost impassable ground, were supplemented by pitchforks and centrifugal pumps in the work of excavating pilot ditches for drainage and cleaning up soft material from the bottom of the cut. Although the machines that excavated these three sections were operated on timber pads giving a large bearing surface, much advance drainage work was required before the peaty soil would support them; and many novel difficulties with mud waves, water pockets and sliding material were overcome before the concrete aqueduct could be built and backfilled. The present article deals with these difficulties, leaving the other construction features to be taken up in a second article, to appear next week.

METHOD OF DRIVING STAKES, USING BRUSH TO HOLD UP SOUPY MUSKEG FROM BOTTOM OF DITCH

Note small ditch made in center to get rid of water so muskeg could be handled. Sometimes as much as 3 ft. of this material had to be taken care of. The cut was all in muskeg; depth about 14 ft.

SOUNDINGS HERE SHOWED 17 FT. OF SOFT MATERIAL

At such places it was necessary to carry the aqueduct on pile foundations

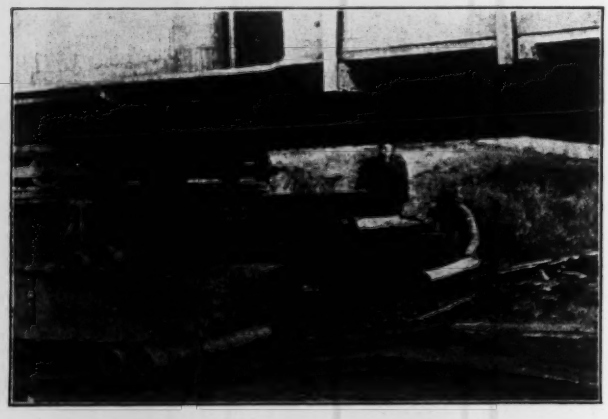
Muskeg Treacherous and Difficult To Handle

The aqueduct at present under construction for the Greater Winnipeg Water District (see *Engineering Record*, May 8, 1915, page 594) will carry water from Shoal Lake to Winnipeg and surrounding municipalities. It will be a little more than 97 miles long, with a fall of about 300 ft. in that distance. A railroad, built by the Northern Construction Co., and owned and operated by the district, parallels the aqueduct line 110 ft. from it. While the westerly portion of country traversed by the aqueduct line is open prairie, the easterly section is mostly open or timbered muskeg varied with a few wooded dry spots. Muskeg is a peaty material in bogs of varying depths and degrees of decomposition of vegetable matter. Until well drained it is of a wet, spongy consistency.

The three easterly contracts, Nos. 32, 33 and 34, approximately 48 miles in length, were awarded to the Winnepeg Aqueduct Construction Co., Ltd., a combination, formed to carry on this work, of two Winnipeg firms, the Northern Construction Co. and the Carter-Halls-Aldinger Co. On first going over the ground, it was readily seen that for this section of the work the main problem would be one of handling the excavation and drainage and taking care of large amounts of water during construction.

After the consideration of several methods and types of machines for handling the excavation, it was decided that the dragline would come nearest to fulfilling the re-

quirements. However, no standard machine seemed to meet the wants of most of the work. Finally, a design submitted by the engineering department of the Bucyrus Co., now known as this company's class 7 machine, was selected. A simple, powerful machine was required, able to maintain the specified rate of progress, to deposit the



HOW MACHINE SETTLED IN MUSKEG
Pad, at right, is on natural ground surface

dirt far enough away from the sides of the cut for safety, and yet light enough to be supported and moved over the softest ground on the line. It was estimated that a 1-cu.yd. bucket would leave a safe margin for the majority of the work; and the boom radius was kept as small as possible, to make for safety and ease of handling.

Fuel Saving at a Premium

Coal being an expensive commodity, averaging $12 per ton on the work, the machines were equipped with fuel-saving devices, including shaking grates with the natural-draft boilers, oil filters for feed water and feed-water heaters and lagging for the boilers and all piping. The machines weigh, roughly, 30 tons. In determining the requirements for the support of this load, it was assumed that on the softest ground or muskeg, where a person walking would sink to his knees, a 150-lb. man would be placing on his points of support a more or less concentrated load of from 350 to 375 lb. per sq.ft. Consequently, it was estimated that a fairly distributed load of 250 to 275 lb. per sq.ft. would be sufficiently low to keep the machine from sinking too deep to handle the rolls.

In this estimate no allowance was made for the extra support from roots, etc. To obtain this support, pads 7 ft. wide by 20 ft. long were made by bolting 4 x 10-in. fir plank 20 ft. long to 6 x 8-in. battens. Five of these pads are used in a set, three of them being under the machine, placed close together and crosswise to the line of excavation. The extra pads were required in moving up and getting around.

Heavy Battens Useful on Pads

The machines have bolted to their structural-steel bases 6 x 10-in. fir skids to which are fastened oak shoes. Under these are 6-in. extra-heavy pipe rollers 4 ft. long, which run on 4 x 10-in. oak plank laid with broken points, the whole being supported on the pads. A good-sized deep batten is an efficient means of support. In soft ground it sinks into the dirt, compacting it under the planks and preventing it from squashing out at the sides. On firmer ground, such battens are strong enough not to break. For handling these pads, four ¾-in. U-bolts are placed at balancing points about the middle third of the pad.

When it is desired to move up, the bucket is drawn in to the pad and a double chain is hooked to each side of the bucket and to the U-bolts. The chains have unequal legs, so that suction is broken along one edge of the pad first. On firm ground, the chains are generally hooked, so the pad is raised toward the machine; but in digging muskeg, there is usually a pile of roots, moss, etc., on the pad close to the machine, and the operator raises the pad in the opposite direction to spill the accumulation away from the machine. After raising the pad is swung into place behind the machine.

After pad, plank and rollers are in position, the machine is hauled ahead by dropping the bucket into the ground, where there is any firm hold, and going ahead on the drag cable. If the ground is too soft to get sufficient purchase, the bucket is drawn up to the edge of the rear pad and pulls against this. The average time taken to move is about three minutes. The usual crew consists of an operator, a fireman, and two groundmen to handle pads and rolls and grub any stump that may be in the way. Coal is carried to the machines from the track, in canvas sacks holding 75 lb. Water is generally obtained from the ditch alongside the railway, about 100 ft. distant, being pumped into the tank by means of a hand pressure pump.

Concreting Influences Excavation Methods

The method of placing excavated material was planned to fit in with the proposed procedure for placing concrete and handling the backfilling of the aqueduct. These operations, as schemed, required the deposition of sufficient spoil on the south side of the cut to make a graded fill high enough above the aqueduct to permit concrete to be chuted from it into the top of the arch forms. The economical elevation of this fill was separately figured for each camp for each season. The point aimed at was to have its grade, if possible without too much borrow, at a sufficient elevation to give the chute a slope of 18 deg. At most of the camps in 1916 there was considerable shallow cutting, 3 to 4 ft. or even less in places. At these points grade was set at the height that could be obtained with the excavation, plus what could be borrowed within boom reach on the north side of the excavation outside the toe of the backfill line. This borrowed material for dump grading at points of shallow cutting came in subsequently for backfill.

Work Carried Upgrade

At each beginning, the start was made working upgrade, a sump was dug to grade outside, where concreting was to start, and a 6-in. centrifugal pump installed. These pumps were all belt driven, the source of power being a 15-hp. two-cylinder four-cycle Westman gas engine. These starting points, where possible, were chosen at some low point in the country near a creek or a drainage ditch. A large number of these ditches were put in during the first season, to remove some of the surface water and make the construction of the railroad possible. Water from the pumps was discharged into

those ditches or creeks. Hand primers were used on all these pumps, and flow was controlled by means of a quick-opening gate valve placed between the pump shell and the discharge pipe. The pumps were run enough to keep water away from the draglines, so that each operator could see what he was doing. In this way the trench was dug as close to grade as possible, leaving 6 in. to be excavated by hand, as called for in the contract.

As the excavation progressed, the spoil placed on the south side shut off most of the surface water from the trench, what surface slope there is being from south to north. By the time gravel was delivered and mixers set up, the draglines had about ¼ mile of trench opened up at each camp. This was in June. A great deal of the surface water had been cut off and drained away from the trenches by placing small earth dams in the ditch and using gas-driven diaphragm or centrifugal pumps to handle the water. The bottom of the trench could be trimmed up by hand and the concrete placed on practically dry foundations. The two machines that were erected first and started in May excavated over 2 miles of trench, when they were taken back to the beginning of the trench and backfilled almost 2 miles each of completed aqueduct by December. On the different sections where they were used, these machines encountered almost all kinds of excavation.

Large Machines Required on East Section

At the most easterly section, started in 1915, the cutting was deeper than could be handled by the small machines, and a Bucyrus class 14 dragline with a 2-cu.yd. bucket and 70-ft. boom was installed with fuel-saving devices similar to those on the small machines. Where this machine started work, the cut for a short distance was shallow; and drainage at this point being from north to south, the dump on the south side of the trench was of no use to cut off a large amount of the surface water. Consequently, a drainage ditch had to be cut on the north side to carry off the water which the pump could not economically handle.

When the heavier cutting started, in about 5 to 6 ft. of muskeg and 4 ft. of sandy clay, there was enough spoil to go on both sides of the cut; and this compressed the muskeg so much that it practically shut off all the surface water from coming into the trench from the sides. At one point in the cut the muskeg was 8 ft. deep with 2 ft. of clay underneath, while in the bottom of the trench there was a soft layer. The weight of spoil on the banks was so great that a short time after this trench was excavated it broke through the layer of firm clay and caused a mud wave that took the line of least resistance and rose in the center of the ditch for several hundred feet to a height of 3 to 6 ft. above grade. When all movement stopped, this portion was re-excavated by hand; and the aqueduct was carried on piles across this stretch.

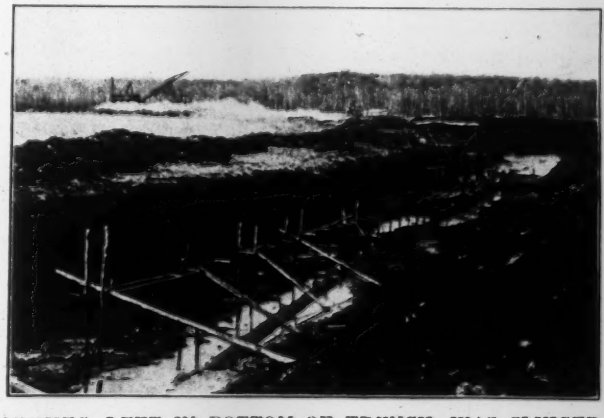
Drain Muskeg Ahead of Concreting

Having a considerable amount of trench excavated ahead of the concreting made it possible to drain the sides of the trench of large amounts of water that could not be got rid of in any other manner. It also gave opportunity to make bearing tests of the trench bottom; and any changes in plans, if poor foundation material was encountered, could be made well ahead of the concreting.

As the excavation progressed farther east at this camp, the muskeg became 10 to 12 ft. deeper, the clay being almost at grade line. Where the muskeg is this deep, it contains a large amount of water that, in running out of the bucket, carries with it a certain amount of fine muskeg. Each time the dragline was ready to move back, there was in the bottom of the trench, for 40 to 60 ft. in front of the machine, a deposit of this soupy muskeg that would not stay in the bucket. Here the operator found a new use for the pads. Those under this machine, 8 x 24 ft., were just about the width of the bottom of the trench as excavated. The operator would hook one pad on the bucket, let it down crosswise in the bottom of the ditch and drag it toward him. After two or three passes, he had the bottom cleaned up and the muskeg compressed into a mass at the toe of the slope stiff enough to be handled in the bucket, thereby saving a great deal of mean hand excavation.

Water Pockets Cause Trouble

As the excavation progressed toward the east, the muskeg became deeper than the grade line of the aqueduct, and soundings ahead showed a depth of 17 ft. The muskeg in this deep cutting carried large amounts of water, and the dragline settled very badly while running. At times, pockets of water were encountered that would gush out from under the pads and drop the machine toward the cut at a perilous angle. When the drag had reached this point, it had already dug more trench than could be concreted that season. After considering several schemes, such as driving piling ahead to carry the dragline, it was finally decided to run the machine ahead, digging a pilot ditch as deep as could be dug without caving in the banks. Doing this, it was possible



MUSKEG, LEFT IN BOTTOM OF TRENCH, WAS SLUICED DOWN TO PUMP AT MILE 98

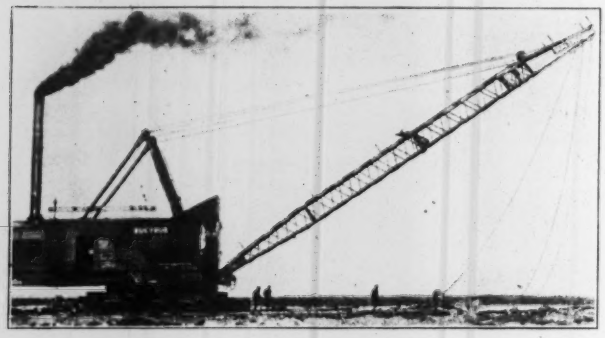
Dirt dike kept out waters of the bay

to take out about one-third of the cut. This ditch, running all winter, considerably lowered the water plane in the adjacent muskeg.

The drag this year was able to complete the excavation to mile 88 by continually going over the line, digging as deep as the banks would hold up, and going over it again. Practically all of the last 2 miles had to be gone over three times, and one stretch eight times, before grade was reached. The drag after the second cut had to work from the south bank, and the scheme of using the

pad as a scraper to clean up the bottom and compress the wet soupy muskeg could not be followed. There would be from 1½ to 3 ft. of soupy muskeg left in the trench.

Stakes about 4 ft. long were driven 3 ft. apart along the sides at the bottom of the trench. Small tamarack and spruce bushes that grew in the vicinity were cut and laid down flat on the muskeg behind the stakes. The



SPOIL FROM EXCAVATION ALONG THE BIG CUT HAS TO BE SPREAD OUT OVER A LARGE AREA

If placed in piles near cut, it causes slides or sinks in muskeg, thus destroying its value as backfilling

soupy muskeg was then excavated by hand and placed on top of this brush, the water draining out and leaving the peat behind. In this way the trench was finally excavated to grade.

Pilot Ditch Dug with Pitchforks

From mile 88 to the summit, at about mile 93½, the country, known as the "big muskeg," is mostly open, the muskeg running from 6 to 10 ft. deep and being very wet and difficult to get around in. A man walking would sink over his knees at every step. It was decided here to spend the first season in getting rid of some of this surface water. At mile 88 there is a small stream emptying into the Boggy River. The company owned a Bay City gas dredge, and with this a pilot ditch about 6 miles long, discharging into this creek, was run south of the line of the aqueduct. It was found after starting excavation that the short section of rail and pads provided with the machine was not suitable for this soft ground.

The only way the machine could be kept up was to lay several pole stringers on each side, narrow-gage 5-ft. ties on top of these, and then a full-length 60-lb. rail for the machine to travel on. The rail and poles were handled forward by placing timber dollies upside down at each corner of the dredge and sliding rails and poles ahead on these supports. When the machine had progressed about a mile, it did not look as if this ditch was going to do much good, the first half mile of the muskeg being deeper than the dredge could dig and the muskeg slowly rising in the ditch to within a foot of the top and blocking it up. A packed cubic foot of muskeg, damp but not wet, weighs about 35 lb.

It was found after trying several schemes that the ditch could be opened up by having a couple of men on planks on opposite sides of the ditch start in with forks at the lower end of the trench and dig a small ditch in the center about 18 in. wide and a couple of feet deep. By carrying this ditch ahead for a quarter of a mile and then coming back, the upper portion of muskeg in the ditch would be drained enough to be somewhat compacted. Chunks could then be broken off with a fork or spade into the running water, which would speedily disintegrate the mass into small particles that would float off. By carrying this fall of a couple of feet, working it off, coming back, making another ditch and repeating the operation, Mr. Cox, the foreman in direct charge of this camp, was able to get the ditch as low as it could be drained. It was allowed to run all winter and made such a marked change in this stretch of country that a Bucyrus class 24 dragline was decided on to handle the excavation.

This machine weighs about 160 tons, has a 100-ft. boom, a 3½-yd. bucket and the same fuel-saving devices as the other draglines. It is supported in the same way, except that the pads are larger, being built of 8 x 12-in. timbers 38 ft. long, with the outer edges reinforced by 8 x 8-in. angle irons to allow using the bucket against them in moving up. The 10 x 12-in. battens that are directly under the rolls on the pads are reinforced with channel iron fitted to the bottom side of each batten and bolted through the batten and platform timbers.

The depth of cut on this section runs at the summit to 23 ft. The remainder of the excavation from the summit, at mile 93½, to Indian Bay is being made with a class 20 machine having an 85-ft. boom and 2½-cu.yd. bucket.

Work Next Lake Started Before Mild Weather

This machine was started last spring at the easterly limit of the line, working west to meet the class 24 dragline. The slope on this section for about 4 miles is only 0.11%; but by keeping the pumps close to the drag, water could be kept down fairly well in front of the machine. The excavation started on the west side of a rocky point that will eventually be pierced through to the main lake for the intake. From the start of the cut, the aqueduct line follows the shore of a bay. For about a quarter of a mile along this shore line for some distance in from the water the bay is filled with a muskeg bog floating on the water. An early start in excavation was made in April, to take advantage of frost in the muskeg for the support of the class 20 machine.

The bog was from 10 to 12 ft. deep to firm foundation; and as the excavation progressed, what little firm material was obtained from the cut was placed on the lake side of the trench to aid in compressing the muskeg and cutting off the water. This season there was the highest water on record, and this small dike had to be continually raised to meet the rising waters until it was holding 3½ to 4 ft. of water out of the cut. The only materials obtainable being fine clay or fine sand and brush, this dike was a continual source of anxiety, and heavy rains and high winds caused several small breaks.

Centrifugal Pump Cleans up Excavation

When the dragline excavation had been completed along the bay, it was found that there had run into the trench from the sides 2 to 3 ft. of fine, soupy muskeg that held water and would not drain off well. At the writer's suggestion a 6-in. centrifugal pump was set up at the deepest point, and a sluice box of 1 x 12-in. lumber that was on hand was built down the center of the trench on a continuous grade. The highest point was low enough to shovel into, and it discharged into a sump at the 6-in. pump. Water was let into this sluice from the lake, being regulated just so the pump could handle it. Men

standing alongside the box shoveled in the soupy muskeg, which was carried to the sump and pumped out into the lake. In this manner it was removed for about one-fifth of what it had been costing.

Between this muskeg excavation and the Falcon River crossing there is a cut of about 15 ft. through a hard sandy clay ridge resting in spots on rock that is mostly below the grade line. Between the clay and the rock at several points, pockets of quicksand were encountered. The method finally worked out to handle these pockets of quicksand, which ran from 5 to 10 ft. below grade, was for the dragline to uncover them, after which 3 x 6-in. tongue and groove sheet piling about 8 ft. in length was driven by hand a couple of feet below invert grade. The main function of this sheeting was to hold the toe of the trench slopes in place. Then a small trench about 18 in. wide would be sheeted in the center of the cut, wales and braces being placed. By bleeding and deepening the 18-in. trench it was possible to get in a section of drain box at a time and surround it with crushed stone. The top of this box would, of course, be below grade. As soon as a section of drain box was set, it was generally loaded with sacks of gravel to hold it down, and the sheeting of the small trench was pulled and moved ahead.

By pumping out these drain boxes the quicksand was freed from water to grade line and was excavated by hand, most of it being thrown on the banks of the cut behind the 3 x 6-in. sheeting, the top of which was left sticking up for this purpose. After excavation was carried to grade, screened crushed stone was dumped into the quicksand until it came up above the grade line. Men worked the mass into the quicksand with steel bars until a solid compact foundation was obtained. Places handled in this way have now been completed and backfilled for some time and have shown no sign of settlement.

Floating Dredge Needed on One Section

From the Falcon River crossing east, the line runs through a basin between two rock ridges in which lies Snake Lake, emptying into Falcon River near its mouth, where it discharges into Indian Bay on Shoal Lake. This basin is muskeg 4 to 12 ft. deep, overlying a sandy clay soil. A Bay City gasoline land dredge was started from a piece of firm ground just east of the river bank, with the intention of building a dike on the Snake Lake side of the trench to compress the muskeg on that side and cut off the water. Shortly after this work was begun, the water in Snake Lake rose rapidly, overflowing the banks about 3 ft. and making it impossible to use the land dredge. The muskeg either swelled or floated to the height of the surface water, and the ground was so softened as to be impassable.

In order to overcome this state of affairs, the land dredge was mounted on a scow and dug its way through the floating muskeg, depositing the spoil on the lake side of the cut and also cutting this diked land into smaller diked sections by building crossdams between the main dike along the lake shore and the railroad dump. As the class 20 dragline came along with the excavation, these small diked sections were pumped out, using the ditch made by the small dredge. In this way a fairly solid soil was formed for the dragline to work on. As the dragline progressed, some of the sandy clay from the bottom of the cut was placed on the outside of the muskeg dike built by the small dredge, converting this into a permanent dike that cut off most of the leakage from the lake side.

It appears that the worst condition of this kind that is likely to be met with has been successfully overcome.

(To Be Concluded)

Neglect of Pipe Leaks Wastes Two Million Gallons Daily

Survey at Washington Shows Calked Lead Joints and Corroded Iron Services Cause Principal Trouble

A DAILY underground leakage of 1,981,600 gal. was detected and stopped by the Water-Survey Division of the District of Columbia during the past fiscal year. According to the 1916 report of the Engineer Department, this amount represents the loss daily through 420 separate leaks that averaged 4700 gal. per day each. This investigation, it is pointed out, clearly reveals the fact that neglect of leaks produces serious conditions, due to their gradual enlargement.

The most fruitful source of leakage was found in the calked lead joints of the small service mains, a total of 101 cases, discharging 607,350 gal. daily, being found. There were also detected 113 corroded iron services, discharging 449,440 gal. daily; wiped joints wasting 342,490 gal. daily; broken lead and pewter services, 201,380 gal., broken cast-iron mains, 142,800 gal., and defective screw couplings, unions, etc., 115,450 gallons.

Not Enough Lead Used

The leaks on the calked joints, it is further explained, were due in most cases to the use of an insufficient quantity of lead. With sufficient lead a calked joint is very flexible, as determined by recent tests; but with old joints, where the quantity of lead was stinted, the slightest deflection in the pipe, due to settlement or other causes, serves to open a crevice through which loss takes place. The small number of defective joints found on all recent pipe-installation work furnishes ample verification of this point. The corrosion of wrought-iron service pipes is taking place rapidly, and constant surveillance must be maintained.

Leaks in the wiped joints on lead services and lead connections to iron services represent work of recent date and of the highest class, where quality apparently was not sacrificed for economy. The question is expressed as to whether some other type of joint should not be used. In the case of the lead services it was found that heavier weight of pipe is proving satisfactory, the same being true of the modern cast-iron mains.

The percentage of metered services was raised to 77.5% by the installation of 5880 meters at a cost of $69,618. Less attention to routine house inspection was necessary because of the growth of the meter service as well as the tendency toward decrease of leaky fixtures in the unmetered houses themselves.

The total cost of running the Division of Water Surveys was found to be somewhat less than that of the previous year, due to the reduction in the number of employees and the substitution of two motor trucks for the five teams previously used.

Heavy Crane Loads and Wide Aisles Control Steelwork Design of Navy's Huge Structural Shop

Mill Building at Norfolk Yard Covers Area 300 x 696 Feet—Column Sections Massive—Crane Girder Spans of 72 Feet Required

WITH the advent of war the United States Government is rushing construction on the large steel-frame structural shop at the Norfolk navy yard, representing the highest grade of modern mill building. The size of the building, its remarkably ample crane facilities and the structural system of the crane runways are distinguishing features. Covering a ground plan 300 x 696 ft., comprising three 100-ft. aisles, the building involves so large a number of units that economy of spans and spacing as well as most efficient design of each unit became an important object. The steelwork is of heavy type, because of the loads and spans called for; only a few bracing girders and some of the roof steelwork are reminders of ordinary light mill-building practice.

Chief Factors in the Design

Heavy crane loads, a complex combination of bridge and jib cranes, and aisles of great width and clear height were the controlling elements in the general design. Large glass areas in the walls, separated by narrow bands of tile filling, form an exterior possessing the qualities of lightness and permanence, but supply no bracing effect to the frame.

The plan of the building, Fig. 1, in conjunction with the cross-section in Fig. 2, shows the simplicity of the general structure. However, there are many detail variations on account of the relative positions and lengths of the several crane runways, the succession of transverse monitors, 24 ft. wide, over the full width of each aisle, the depressed middle aisle and the mold-loft built into the east aisle.

Distinctive features of the design, as it was worked out by the McClintic-Marshall Construction Co., of Pittsburgh, are the massive column sections, the column footings, the girders for the large bridge cranes on spans of 48 and 72 ft., and the compact truss system devised for carrying the runways of the wall cranes and 15-ton bridge cranes at the interior lines of columns.

The east wall of the building has its columns arranged at 24-ft. spacing. The west wall—arranged for adding another aisle in the future—and the two interior lines of columns have double spacing, 48 ft., to produce least obstruction of floor space. The roof trusses in these lines are carried by longitudinal trusses extending between the columns just below roof-truss level. One of these is shown at the right of Fig. 2 in the part elevation of the west wall.

At midlength of each of the west-wall trusses an auxiliary "column," or rib, is carried down, serving to support the wall girts and the outer members of the horizontal lattice girders that stiffen the wall-crane tracks. That part of the rib which is below the lowest crane runway will be removed, with the girts, when the building is extended and the wall taken out.

On account of the wide column spacing, the crane girders have large spans and require unusual proportions; this applies both to the bridge-crane girders and to the horizontal and vertical girders for the wall-crane runways. As a result there are large reactions at the columns, and the thrust of the wall cranes produces transverse bending moments that were an important factor in the column design.

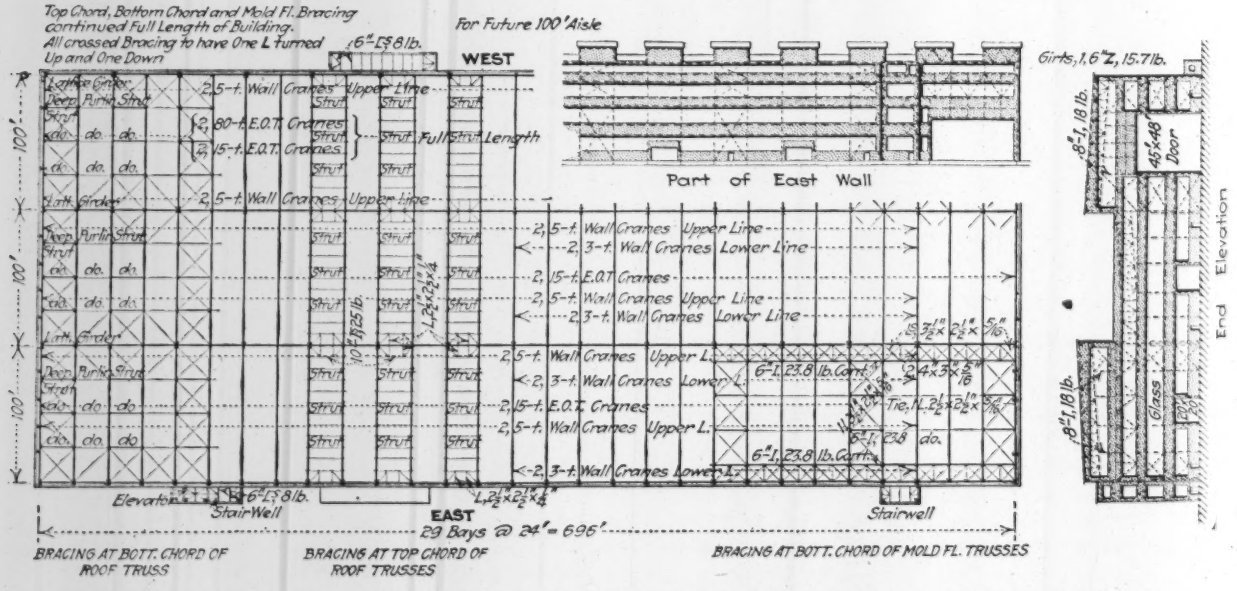
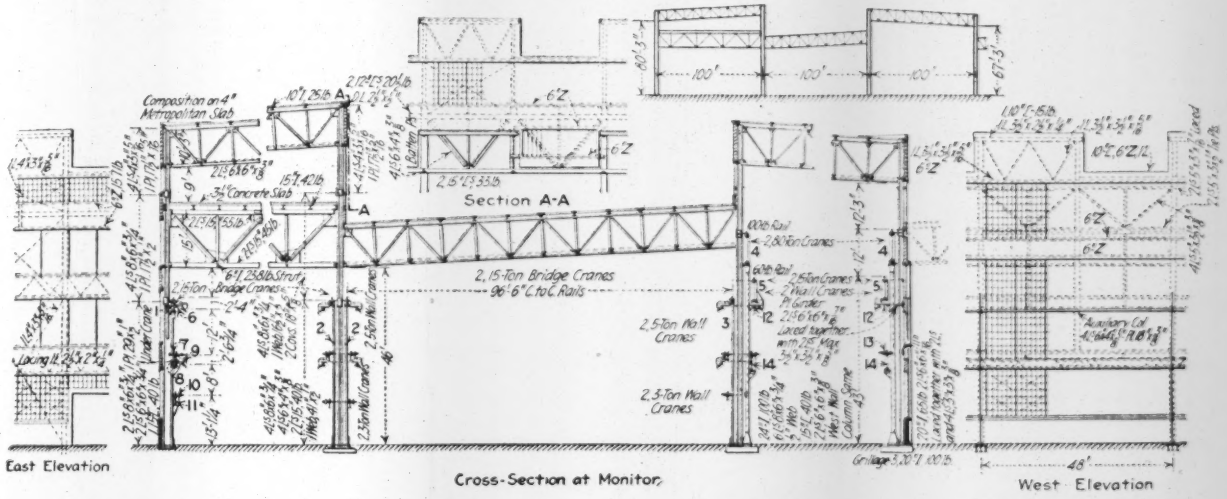

Top Chord, Bottom Chord and Mold Fl. Bracing continued Full Length of Building. All crossed Bracing to have One L Turned Up and One Down
For Future 100' Aisle
WEST
EAST
Part of East Wall
End Elevation
Girts, 1, 6" Z, 15.7 lb.
Stairwell
Elevator
29 Bays @ 24" = 696'
BRACING AT BOTT. CHORD OF ROOF TRUSS
BRACING AT TOP CHORD OF ROOF TRUSSES
BRACING AT BOTT. CHORD OF MOLD FL. TRUSSES

FIG. 1. LARGE STRUCTURAL SHOP BEING BUILT FOR NORFOLK NAVY YARD; PLAN OF STEEL FRAME

The columns are of the type common in heavy mill-building work. They comprise a wide I-shaped base portion up to crane-girder level, with a channel along the inner flange to take the crane-girder load and stiffen the flange laterally; and a narrower I-shaped prolongation of the outer part, to carry the roof load. This type is found in characteristic form in the east-wall columns, 29 in. wide in their lower part. The wall-crane runways (of 24-ft. span) are supported by brackets riveted to the inner face of the columns, and each girder is made up of a vertical and a horizontal plate girder, which suffices for the 24-ft. span.

The interior columns and the west-wall columns are of modified form because of carrying cranes on both sides; the west-wall columns will be interior columns when another aisle is added. Because of the very heavy bridge-crane loads in the smith shop (west aisle), the crane flanges facing this aisle consist each of a heavy I-beam whose web is riveted by connection angles to the edge of the column web plate, while the opposite flange is of channel construction. The interior columns in the C-line therefore are unsymmetrical, while those in the B-line have channel flanges on both sides. The west-wall columns (D-line) are identical with the C-columns, according to the specifications.

In proportioning the columns for the large bending moments produced by the lateral thrusts of the bridge cranes and the horizontal couples from the jib cranes, the column was assumed to be pin-ended, so that the reactions at top and bottom are equal to the quotient of total moment divided by the height between supported points.



1. Girder for Two 15-T. Bridge Cranes

24-Ft. Bay	72-Ft. Bay
Web 36 x $\frac{3}{8}$ in.	Web 78 x $\frac{3}{8}$
Bott. fl. 2 Ls 6 x 6 x $\frac{1}{2}$	Bott. fl. 2 Ls 8 x 8 x $1\frac{1}{8}$
Top fl. 2 Ls 6 x 6 x $\frac{1}{2}$	1 pl. 20 x $\frac{3}{8}$
1 15-in. channel 33 lb.	Top fl. 2 Ls 8 x 8 x $1\frac{1}{8}$
End riv. pitch $1\frac{3}{4}$ in.	1 pl. 40 x $\frac{5}{16}$
	1 L 6 x 4 x $\frac{3}{8}$
	End riv. pitch $2\frac{1}{4}$ in.

2, 3. Crane-Girder Trusses, see Fig. 3

4. Girder for Two 80-T. Bridge Cranes

48-Ft. Bay	72-Ft. Bay
Web 96 x $\frac{1}{2}$	Web 100 x $\frac{3}{8}$
Bott. fl. 2 Ls 8 x 8 x $\frac{3}{4}$	Bott. fl. 2 Ls 8 x 8 x $\frac{3}{4}$
1 pl. 21 x $\frac{3}{8}$	3 pl. 21 x $\frac{1}{16}$
Top fl. 2 Ls 8 x 8 x $\frac{3}{4}$	1 pl. 21 x $\frac{3}{8}$
1 pl. 21 x $\frac{1}{2}$	Top fl. 2 Ls 8 x 8 x $\frac{3}{4}$
1 pl. 44$\frac{1}{2}$ x $\frac{3}{8}$	3 pl. 22 x $\frac{3}{4}$
1 L 6 x 6 x $\frac{3}{8}$	1 pl. 45 x $\frac{1}{2}$
End riv. pitch $1\frac{1}{2}$ in.	1 L 8 x 8 x $\frac{3}{4}$
	End riv. pitch $1\frac{1}{2}$ in.

5. Girder for Two 15-T. Bridge Cranes

48-Ft. Bay	72-Ft. Bay
Web 66 x $\frac{3}{8}$	Web 100 x $\frac{3}{8}$
Bott. fl. 2 Ls 6 x 6 x $\frac{3}{4}$	Bott. fl. 2 Ls 8 x 8 x $\frac{3}{4}$
Top fl. 2 Ls 6 x 6 x $\frac{3}{4}$ laced to	3 pl. 21 x $\frac{11}{16}$
1 L 5 x 3$\frac{1}{2}$ x $\frac{3}{8}$	1 pl. 21 x $\frac{3}{8}$
End riv. pitch $2\frac{1}{4}$ in.	Top fl. 2 Ls 8 x 8 x $1\frac{1}{16}$
	1 pl. 20 x $\frac{3}{8}$ laced to
	1 L 5 x 3$\frac{1}{2}$ x $\frac{3}{8}$

6. Upper Girder for Two 5-T. Wall Cranes (24-Ft. Bay)
Web 32 x $\frac{5}{16}$
Outer fl. 1 6-in. Z, 29.3 lb.
1 L 6 x 4 x $\frac{3}{4}$
Inner fl. 2 Ls 6 x 4 x $\frac{3}{8}$

7, 8. Lower Girders for Two 5-T. Wall Cranes (24-Ft. Bay)
24-in. I, 105 lb.
Web 36 x $\frac{7}{16}$
Bott. fl. 1 L 6 x 3$\frac{1}{2}$ x $\frac{3}{8}$
1 L 3$\frac{1}{2}$ x 3$\frac{1}{2}$ x $\frac{3}{8}$
Top fl. 2 Ls 5 x 3$\frac{1}{2}$ x $\frac{3}{8}$

9. Upper Girder for Two 3-T. Wall Cranes (24-Ft. Bay)
Web 26 x $\frac{5}{16}$
Outer fl. 1 6-in. Z, 29.3 lb.
1 L 6 x 4 x $\frac{3}{8}$
Inner fl. Ls 6 x 4 x $\frac{3}{8}$

10, 11. Lower Girders for Two 3-T. Wall Cranes (24-Ft Bay)
24-in. I, 80 lb.
Web 30 x $\frac{5}{16}$
Each fl. 2 Ls 4 x 3 x $\frac{3}{8}$

12. Upper Girder for Two 5-T. Wall Cranes (48-Ft. Bay)
Web 32 x $\frac{3}{8}$
Outer fl. 1 6-in. Z, 29.3 lb.
1 L 6 x 4 x $\frac{3}{4}$
Inner fl. 2 Ls 3$\frac{1}{2}$ x 3$\frac{1}{2}$ x $\frac{3}{8}$

13, 14. Lower Girders for Two 5-T. Wall Cranes (48-Ft Bay)
20-in. I, 65 lb., laced to
2 Ls 6 x 6 x $\frac{11}{16}$
Web 54 x $\frac{5}{16}$
Bott. fl. 2 Ls 6 x 6 x $\frac{7}{16}$
Top fl. 2 Ls 6 x 6 x $\frac{7}{16}$

FIG. 2. WIDE AISLES AND LARGE CRANE CAPACITY REQUIRE HEAVY STEEL, AS SHOWN BY CROSS-SECTION OF BUILDING

Crane-Girder Construction Complicated

The complicated crane-girder construction used for the wall cranes at the two middle lines of columns is shown in Fig. 3. The three sets of wall-crane runway rails and one bridge-crane track are carried by a deep, stiff truss built between the upper and the middle sets of runway rails, with hangers extending down to the lower rail. There being such a truss and hanger system on each side of the column, the two are braced together in the three planes of the runway rails respectively by wide horizontal trusses or lacing systems. The whole structure thus represents a box-shaped truss system having an upper and a lower compartment, or in other words comprising two vertical trusses and three horizontal trusses.

The make-up of the heavy crane girders is given in connection with Fig. 2. The maximum load from two cranes exceeds 300 tons on a 42-ft. length of girder; this has to be carried on 48-ft. spans, and in the last bay at the north end of the building on a span of 72 ft. The crane girder here has to carry a total vertical moment of about 10,000,000 ft.-lb. and a side moment on the top flange of about 500,000 ft.-lb. This girder is 100 in. deep, and its top flange is formed into a horizontal plate girder 45 in. deep, with an 8 x 8 x ¾-in. angle as flange on its outer edge. In comparison the 24-ft. crane runway for the two 15-ton cranes operating in the east aisle is a 36-in. plate girder whose top flange of two 6 x 6 x ½-in. angles is stiffened by a 15-in. channel. The moment to be carried by this girder is only 487,000 ft.-lb. vertical, and the other values corresponding. These figures apply to the crane loadings assumed for the original design; the actual crane loads, being slightly different, give correspondingly modified results.

The load requirements for the design of the building contain some interesting points. The roof live-load in general was taken as 15 lb. per sq.ft. for design of the roof slab and purlins, 12 lb. for the trusses and 10 lb. for the columns. The trusses, however, were proportioned further for horizontal wind pressure of 20 lb. per sq.ft. on the unloaded structure, or 10 lb. on the loaded structure. For the mold-loft floor a live-load of 100 lb. per sq.ft. is used, but only 80-ft. live-load is counted for the truss design.

For the two superimposed bridge-crane runways in the smithery it was at first specified that the two 80-ton cranes need not be considered acting simultaneously with the two 15-ton cranes, nor would the wall cranes act at the same time as the bridge cranes. This original requirement, however, was subsequently modified to call for simultaneous operation of the wall cranes, two 80-ton bridge cranes in the smithery and one 15-ton crane in the plate shop, the load being at midspan.

All crane runways were required to be designed for a lateral thrust equal to 10% of the crane capacity load plus weight of crane trolley, divided equally among the wheels on one runway. The vertical effect was taken equal to the maximum wheel loads plus 25% impact.

Unit Stresses Specified

The following clause governed the unit stresses for the design:

Unit Stresses—The structural steel shall be proportioned so that the sum of the dead and live loads, together with impact, when used, shall not cause the stresses to exceed the following amounts in pounds per square inch:

Tension, net section, rolled steel	16,000
Direct compression, rolled steel and steel castings	16,000
Bending on extreme fibers of rolled shapes, built sections, girders and steel castings	16,000
Shear on shop rivets and pins	12,000
Shear on bolts and field rivets	10,000
Shear, average, on webs of plate girders and rolled beams, gross section	10,000
Bearing pressure on shop rivets and pins	24,000
Bearing on bolts and field rivets	20,000
Axial compression of gross sections for ratio of l/r up to 120	16,000 − 70l/r
with a maximum of	13,000

where l = effective length of member in inches
r = corresponding radius of gyration of section in inches

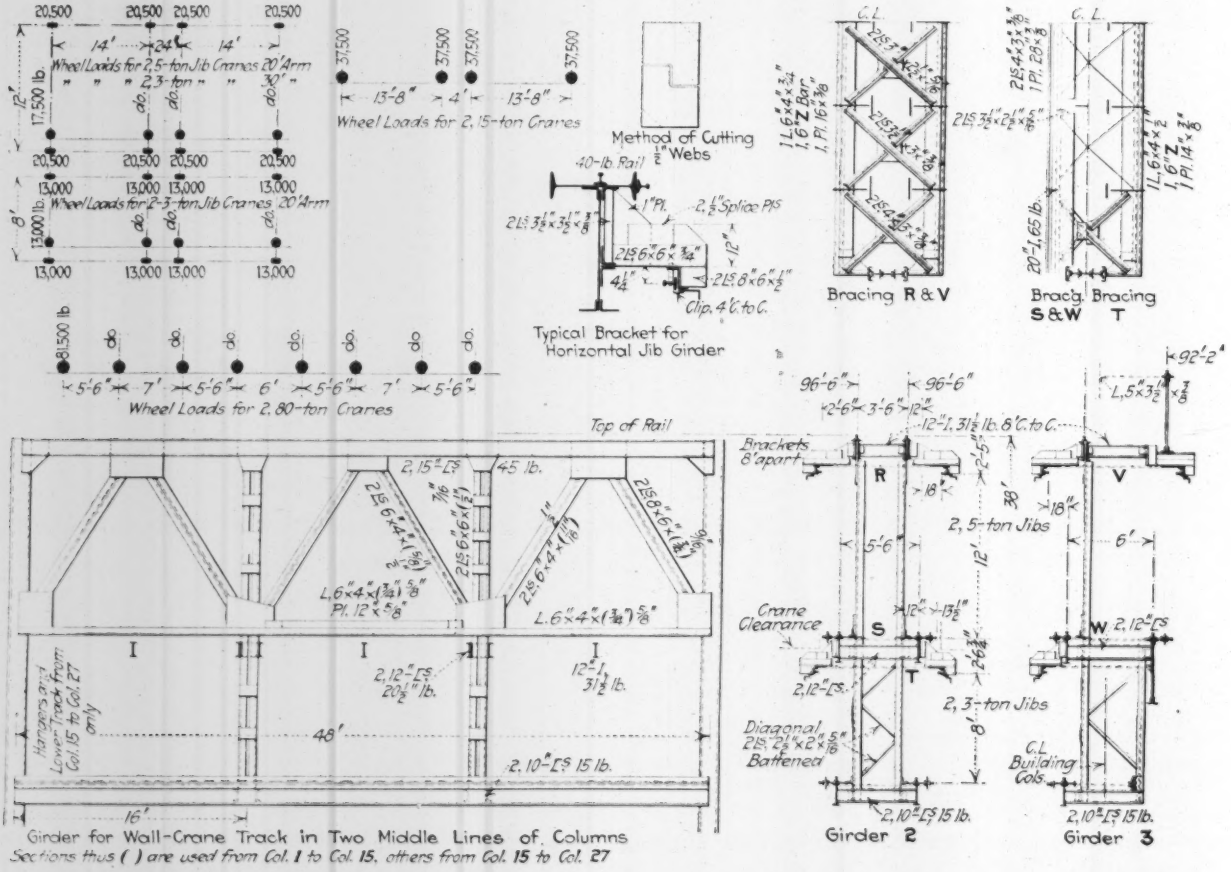

Wheel Loads for 2,5-ton Jib Cranes 20'4rm
Wheel Loads for 2,15-ton Cranes
Wheel Loads for 2-3-ton Jib Cranes 20'4rm
Wheel Loads for 2,80-ton Cranes
Method of Cutting ⅝" Webs
40-lb. Rail
Typical Bracket for Horizontal Jib Girder
Bracing R & V
Brac'g. Bracing S & W T
Top of Rail
Brackets 8' apart
2,5-ton Jibs
2,3-ton Jibs
Crane Clearance
Diagonal
Girder 2
Girder 3
Girder for Wall-Crane Track in Two Middle Lines of Columns
Sections thus ( ) are used from Col. 1 to Col. 15, others from Col. 15 to Col. 27

FIG. 3. SIX CRANE RUNWAYS AT INTERIOR COLUMN LINE ARE CARRIED BY A COMPLEX ASSEMBLAGE OF TRUSSES

For members subject to combined stresses due to wind, dead and live loads, the working stresses may be increased 25% provided the section thus found is not less than that required for dead and live loads alone.

The roof is made of a waterproof composition laid on a 4-in. Metropolitan gypsum slab, supported by I-beam purlins. This slab is reinforced by strands of wire cable running transversely across the roof, the ends fastened to the eave purlins. The eave purlins are braced to the adjacent line of purlins, to take the strain of the reinforcing cables.

The mold-loft floor is composed of a 3½-in. continuous concrete slab reinforced by twisted steel rods. On this slab is laid a tongued-and-grooved hardwood floor nailed to wooden sleepers.

The general layout for the shop was made by the Bureau of Yards and Docks, Navy Department, Washington, D. C., under the direction of Admiral F. R. Harris, Chief of Bureau. Subject to this layout and the specification of clearances, capacities, etc., the design was prepared by the McClintic-Marshall Co., Pittsburgh. George E. Wyne is general contractor for the construction of the building. The steelwork is now being fabricated at the McClintic-Marshall shops. The total weight of steel in the building is about 5600 tons.

Elevation vs. Depression, and Track Change vs. Street Change

A. R. E. A. Committee Discusses Advantages and Disadvantages of Four Main Forms of Grade Separation

FOUR main forms of grade-crossing elimination—by elevating the tracks, by depressing the tracks, by elevating the streets and by depressing the streets—were discussed at considerable length in the report of the Roadway Committee of the American Railway Engineering Association, presented at the recent convention. The most obvious conclusion reached by the committee is that with a small number of streets the track profile should, if possible, be left undisturbed, while with numerous built-up crossings the railroad grade must usually be changed. The committee suggests track elevation for industrial districts and track depression for residential districts. It also points out the frequent possibility of having streets vacated, and lateral streets substituted for crossings. In general, the committee notes that each case should be settled on its merits, but its presentation of the relative advantages and disadvantages of these four types and combinations of them may be helpful in making the choice.

Factors in Grade Separation

As salient points in making a grade-separation study, the committee cites physical conditions, embracing subsoil, water and drainage, and material (including consideration of the questions of excavation, haul, borrow and disposal); railway operation, embracing motive power, character of traffic and volume of traffic; grades and alignment, subheaded as railways, streets and abutting property; right-of-way, embracing present and future development, width and value; the district, whether residential, commercial or industrial; and lastly public utilities, subheaded as improvements, interference and damage. For residential districts the questions of value, improvements and damages would govern. In commercial districts value, present and future traffic, track connections and expansion must be considered, and the same features present themselves in industrial districts.

As between full track elevation and full track depression, it is pointed out that, because of the difference in the required clearances, track elevation changes the grade from 16 to 18 ft., while depression changes it from 24 to 28 ft. This difference will materially affect the grades and the cost.

Drainage is sometimes difficult, in both track depressions and street subways. Pumping, which has to be resorted to when the cut is too deep for direct drainage, is expensive in operation and liable to accident. As sewers are usually fairly deep, however, and the clearance for street subways may often be reduced to only 12 ft., it is more probable that direct drainage can be obtained for subways than for track-depression cuts.

Changes in Underground Facilities

Track depressions frequently require elaborate changes in underground facilities, all of which are usually avoided when the tracks are elevated. To avoid disturbance of such facilities, partial track depression is sometimes advisable in districts not too much built up. While this necessitates raising the grade of the cross-streets approaching the cut and may entail damages for buildings, it avoids siphoning sewers, reduces excavation and retaining walls and utilizes the spoil in grading up the street. By this means, too, the tracks in the cut are brought to a convenient level for serving the basements of adjoining buildings.

Partial elevation will bring the level of the tracks to a convenient height for delivering goods to the second floor of adjoining buildings. Here, too, the spoil from the subway excavation may be used in the railway fill and reduce the amount of haul and borrow.

For service to adjoining industries a fully elevated line may have an advantage over a fully depressed one. A building may be more readily adapted to elevated connection without extraordinary expense. It is also usually easier to maintain operating connections with industries while tracks are being elevated than while they are being depressed.

Comparative Grading

For equal depths track depression usually requires more width of roadbed, on account of the necessary ditches. If the full right-of-way is occupied, track depression might call for the abandonment of one of the tracks or the purchase of additional lands.

Under the same conditions more material will usually have to be moved for track depression than for track elevation, and at a higher unit price. On the other hand, the cost of land for borrow pits, the length of haul and the interference with regular traffic in the case of track elevation, considered with the value of low land that may be reclaimed by dumping spoil in the case of track depression, may throw the balance in favor of the latter.

Ordinarily, the difference in cost of bridges would be slight, but may be in favor of track depression, as elevated bridges come under more general observation and call for more artistic treatment. Objections comparable to supports in roadways are not encountered in track de-

pression, except where yards are to be crossed, where it may be necessary to rearrange or abandon tracks to accommodate the required supports.

Public annoyance from smoke and gases will be less, especially at street crossings, with elevated than with depressed tracks. On the other hand, in the matter of noise the cut is preferable. Hence, where tracks are electrically operated, depressed tracks may have the advantage, especially as they afford the opportunity to utilize the "aërial" rights, as at Grand Central Terminal, New York.

Construction Difficulties

Tracks cannot be raised piecemeal under traffic in a city without closing cross-streets, unless the traffic may be temporarily carried on narrow crossings by elevating them with the tracks. This, however, is extremely expensive and may call for abnormal grades.

With single tracks, practically the only way is to make a temporary detour. With double tracks, the tracks may be gantleted, or all traffic turned to one track, operated in both directions. Trestling is usually necessary for a fill, often heavy enough to carry the regular traffic; and where the traffic is sufficiently dense to preclude work trains operating on the same track, a second dumping trestle may have to be built.

Where partial elevation or depression is adopted, the cross-streets must be treated one-half at a time, the change of traffic to the new grades being made simultaneously both on the railway and on the street. When the municipality is participating in the expense, it will usually close as many streets as possible during construction.

Conclusions

These four definite conclusions were reached by the committee and were adopted by the association:

1. Whenever grade separation through densely built-up thoroughfares (short blocks, say from 12 to 15 crossings per mile) becomes imperative, elaborate studies of the kind and volume of traffic on each thoroughfare should be made and due records kept with a view to eliminating or vacating certain of these crossings as wholly unjustifiable from a cost standpoint, and opening lateral streets at a less cost in their stead.

2. If only a few crossings are to be eliminated in an industrial district, with reasonable assurance that no others will be required, the methods used, other things being equal, should not disturb the tracks.

3. If several crossings are to be eliminated in an industrial district, the most efficient method, other things being equal, is by track elevation.

4. In a residential district, if grades and other conditions on the railway will permit, complete depression, allowing the streets to remain at their original level or nearly so, is the preferable method.

State Aid for Wide Tires

The State Highway Commission of Missouri has suggested the possibility of encouraging the use of wide tires by a system of bounties. It proposes that the legislature allow a rebate of $2 per wheel in 1917 for each wheel having a wide tire, and 25c. less annually until it is $1, in 1921, and at this rate for the five years thereafter—wide tires to be made compulsory in subsequent years. The owner of a wide-tired wagon may present a certificate of such ownership as part payment of his taxes.

Monolithic Brick Pavement Tried in the Northwest

King County, Washington, Building a Nine-Mile Stretch—Absence of Good Bond with Concrete Noted

By A. P. DENTON
Former King County Engineer, Seattle, Wash.

IN PLANNING the construction of a highway to follow a new route between Seattle and Tacoma, Wash., the Board of County Commissioners of King County decided on a monolithic brick pavement. Nine and one-quarter miles will be paved, because this new route, to be known as the Highline Road, is 10 miles shorter than the Pacific Highway, now in use, and will bear, when paved its entire length, the major portion of through traffic.

The contract was awarded on Apr. 26, 1916, to F. McLellan, of Seattle, for $222,691.22. The approximate quantities covered by the original contract were as follows:

Monolithic brick pavements, sq.yd	113,906
Asphaltic concrete on bridges, sq.yd	1,284
Roadway excavation, cu.yd	6,400
Subgrade excavation, cu.yd	16,600
Style 20-A triangular mesh reinforcement, sq.yd	3,555
Lumber, ft., b.m	14,000
Monuments and cases	55
Culvert pipe of various sizes, lin.ft	325

Dimensions and Costs

The roadway section was required to be 20 ft. in width with 3 x 6-in. wooden headers; 2½-in. parabolic crown; 1:3:6 concrete base, with flat subgrade, 3 in. thick at the edge and 5½ in. at the center; ¼-in. 1:3 cement-sand cushion. Upon the cushion is laid the vertical-fiber brick, 4 x 8½ in., 2¾ in. deep. In place of lugs, each brick is scored with 24 vertical V-shaped grooves, nine on each side and three on each end. These grooves are ¼ in. wide at the face and ⅛ in. in depth.

After the contract was awarded, it was found that the vertical-fiber brick could not be obtained as fast as they were needed (physical conditions on the road required the immediate delivery of about half of the brick needed to complete the job), so the Denny-Renton Clay and Coal Co., manufacturer of the brick, was allowed to substitute about 2,000,000 standard paving blocks, to be laid flat. These blocks are 3½ in. in depth and have the same surface dimensions as the vertical-fiber brick. The bricks are grouted with a 1:1 cement grout.

The first pavement was laid on June 6, 1916. Between that date and Oct. 31, there was completed 91,500

BRICK PAVEMENT IN STATE OF WASHINGTON

sq.yd. of pavement. The average paving crew was as follows:

		Per Day
Superintendent	1	$6.00
Mixer crew:		
1 foreman	1	4.00
1 mixer engineer		5.00
2 subgrade men		2.75
4 shovelers		2.75
8 wheelbarrow men		2.75
2 cement men		2.75
2 concrete spreaders		2.75
1 concrete rodder		2.75
Cushion crew (5 men)		2.75
Brick crew:		
1 bricklayer		7.00
1 batter-in		3.00
1 liner		2.75
6 carriers		2.75
4 pilers		2.75
Grout crew (8 laborers)		2.75
Covering, uncovering and sprinkling (2 men)		2.75
Curb forms:		
1 man		4.00
1 helper		2.75
1 water boy		1.50

The labor costs per square yard for the 91,500 sq.yd. laid are given in the table. The cost of covering and uncovering the pavement is included in the several items, but cannot be accurately segregated, because the concrete and brick crews were put on this kind of work at such times as best suited the contractor's convenience.

LABOR COSTS PER SQUARE YARD FOR 91,500 SQ.YD. LAID

	Per Sq.Yd.
1:3:6 concrete base, 3 in. at edge, 5½ in. at center and 20 ft. in width (average thickness, 4¾ in.)	$0.0857
Bricklaying	.0724
Sand-cement cushion	.0185
Grouting	.0332
Sprinkling	.0046
Curb forms	.0118
Total	$0.2262

Concrete for the base was mixed in a No. 16 21-ft. Koehring mixer of the boom and bucket type. The sand-cement cushion was mixed in a 3-ft. Little Wonder mixer. The bricks were handled by laborers with brick clamps.

Construction Methods

After having been carefully subgraded and rolled with a 10-ton roller, the subgrade was checked with a templet. All soft or spongy spots were carefully excavated and backfilled with gravel or some other suitable material. In warm weather the subgrade was thoroughly wet down before the concrete base was deposited.

Concrete for the base, a 1:3:6 mixture, assuming 4 cu.ft. per barrel of cement, was mixed for a period of not less than 45 sec. and deposited upon the subgrade in a condition of quaking consistency, as described in Bulletin 58 of the Bureau of Standards. The surface of the base was struck off with a templet and floated.

The sand-cement cushion—1 part of cement and 3 parts of sand—was mixed in a small gasoline 3-ft. mixer, carried on planks, just back of the large mixer. As soon as the base was floated, the cushion was spread; and upon this the bricks were immediately laid. They were then rolled with a hand roller 30 in. in width and weighing about 750 lb. If any depressions or high points developed, the pavement was tamped with heavy wooden tampers pounding upon 2 x 12-in. planks, at least 12 ft. long and laid parallel with the center line of the road.

After the bricks were laid and rolled, and before being grouted, they were thoroughly sprinkled, so that the cushion became of the consistency of a mortar. The grout—1 part sand to 1 part cement—was then applied in two courses, or more if necessary. The first course was quite thin and was brushed into the pavement with fiber brooms, and the second course, of a thick, creamy consistency, was applied with squeegees. The latter operation was repeated as often as required to give a perfectly grouted pavement.

From the time the base was laid until the pavement was grouted, great care was taken that sufficient time did not elapse for an initial set to take place. As soon as the grout had set sufficiently, the pavement was covered to a depth of from 1 to 2 in. with earth taken from the side of the roadway, and the pavement was then kept thoroughly wet for 10 days. Traffic was kept off the pavement for 30 days from the date of laying.

Condition After Completion

During the progress of the work, brick were taken out from time to time to see if they were adhering to the base and forming a true monolith. It was found that they were not, that while some adhered partly, the adherence was not uniform. To remedy this condition, the use of a mortar in place of a dry cushion was tried. The elimination of the cushion and the laying of the brick upon the well-floated concrete base were also tried. None of these methods resulted in a uniform adherence of the brick to the base.

Contrary to the general opinion, it is the belief of the writer that this nonadherence will not in itself cause the failure of the pavement. It is his opinion rather that the success of this type of pavement will more largely depend on the ability of the brick to withstand pressure without rupturing.

In conformance with the specifications of the National Paving Brick Manufacturers' Association, the pavement is laid without transverse expansion joints. Had concrete curbs instead of wooden headers been used, longitudinal expansion joints would have been provided.

An examination of the pavement during December shows small transverse contraction cracks at intervals of from 25 to 200 ft. There is a marked tendency for cracks to appear at the beginning of the day's run. The contraction cracks appear to be closest together along those portions of the pavement that were laid during the warmest weather. There are a few loose bricks, but on the whole the surface presents a very smooth appearance and is an exceptionally easy riding pavement.

Electric Locomotives More Costly To Maintain

Electric locomotives on the Norfolk & Western Ry., according to that company's report for the six months ended Dec. 31, 1916, have proved much more expensive to maintain and operate than steam locomotives. The average cost of repairs, power and lubricants for electric-locomotive equipment per 100 locomotive-miles was $62.90, while that of repairs, fuel, stores and lubricants for steam-locomotive equipment was only $25.21. Repairs were respectively $32.69 and $12.70. Power and lubricants for the electric locomotives cost $30.21 per 100 locomotive-miles as against $12.51 for fuel, stores and lubricants for steam locomotives.

A table in the report divides the steam equipment by divisions and by classes of locomotive (passenger and freight). On the Pocahontas division, which is the one electrified, repairs to freight and to passenger steam locomotives cost respectively $14.60 and $8.53, while fuel, stores and lubricants cost $15.86 and $6.01, making totals respectively of $30.46 and $14.54.

Tunnel Under Hudson Designed for Vehicular Traffic

Engineers Recommend That Tube Between New York and New Jersey Be Built by Floating Sections to Place and Sinking

IF ACTION is taken upon recommendations contained in a report submitted Jan. 30 to the Public Service Corporation of New Jersey by a board of engineers consisting of Prof. William H. Burr, Ralph Modjeski and Daniel E. Moran, motor vehicles, at the rate of 1760 per hour, will be able to pass underneath the Hudson River between New York and Jersey City in a reinforced-concrete tube, to be built of sections floated to place and sunk upon a pile foundation in a trench dredged in the bed of the river. The tunnel, more than 9000 ft. between portals, will be large enough to accommodate two lines of traffic in opposite directions. A complete system of ventilation is an important feature of the project, which, at normal prices, is estimated to cost $6,899,000 and to require two years for completion. At present prices, however, 30% or an additional $2,000,000, is added to the foregoing estimate.

Designed to cross under the river from Grove St., in New York City, to 12th St., in Jersey City, the clear roadway space of the tube will be 25 ft. wide by 13 ft. high and will allow vehicles having a width of 8 ft. to pass with a clearance of 3 ft. 6 in. Under these conditions a speed of 10 miles per hour is not considered dangerous and will permit a minimum safe headway of about 60 ft. The tunnel length being 5500 ft. from shaft to shaft, 183 vehicles would be occupying the under-river section; and since natural ventilation would hardly take care of the air vitiated by exhaust gases, a blower system with a capacity of 360,000 cu.ft. of fresh air per minute would be necessary.

Seek Remedy for Present Conditions

Vehicular traffic between Jersey City and New York depends at present upon 13 ferries, the major part of the commercial burden being carried by five lines. Due to unavoidable delays traceable to adverse weather conditions and to the inherent lack of elasticity of this method, there is no doubt, the report states, that interstate business at this point is not fully developed. In 1906 the legislatures of both New York and New Jersey created commissions to study the subject of vehicular highways between the two states. While reports were submitted to both bodies—one by Boller, Hodge & Baird for a bridge at 57th St., at a cost of $42,000,000, and another by Jacobs & Davies, consulting engineers, for a pair of tunnels at 12th St., to cost $11,000,000—no definite action was taken. The most recent development is the report to the Public Service Corporation of New Jersey from which the following information has been taken:

Traffic Counts Made

Several counts of vehicles using the Cortlandt, Barclay, Chambers, Desbrosses and Christopher St. ferries were made, and the location originally recommended by Jacobs & Davies was determined upon.

A tunnel would undoubtedly provide a quicker method of crossing for motor-driven vehicles than is furnished by the ferries, though not as advantageous for horse-drawn vehicles. The greater rapidity of increase in percentage of motor vehicles over the structures of the Department of Bridges, New York City, in comparison to that shown by ferry statistics, indicates the advantages of bridges, and no doubt of tunnels.

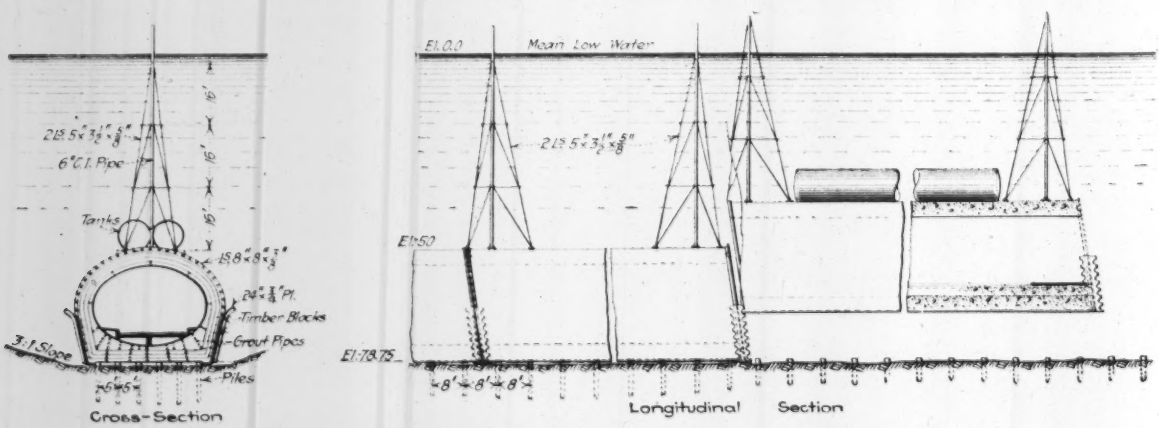
PERCENTAGE OF MOTOR VEHICLES TO TOTAL VEHICLES ON FERRIES

	1913	1915	1916
Cortlandt St., P. R.R	11 29	17 8	24 11
Barclay St., D., L. & W. R.R	6 5		16 13
Chambers St., Erie R.R	3 64	14 7	14 07
Desbrosses St., P. R.R	12 43	22 7	30 93
Christopher St., D., L. & W. R.R	8 64		17 5

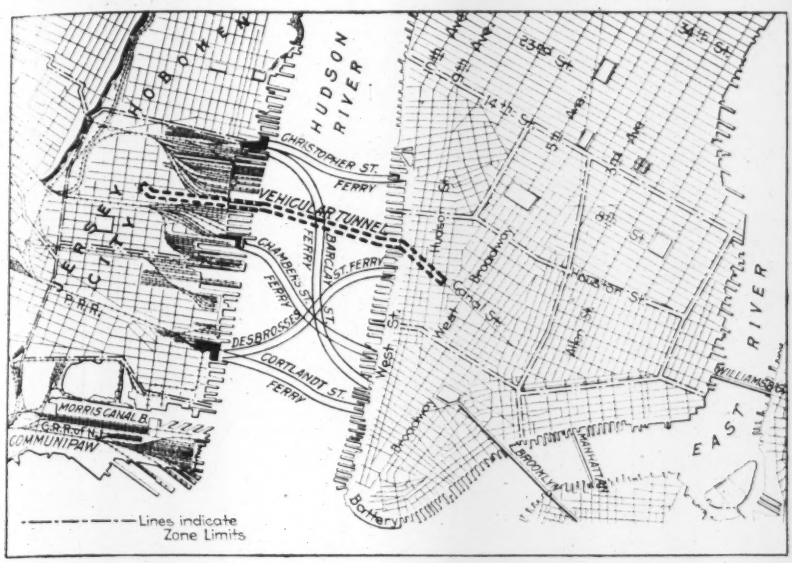
Figures show that, in 1914, of the total vehicles crossing the East River bridges 49.4% were motor driven, and that in 1915 the number had increased to 59.6% and in 1916 to 67% of the total.

Study Possible Time Saving

The drivers of horse and motor trucks crossing the five ferries in both directions were interviewed during the month of March, 1916, and information was obtained as to the starting point and destination of each vehicle. A record was thus made of the movement of 8146 tons and should give a very fair indication of the routing of traffic between points in New Jersey and points in New



SECTION COMPLETED AT SHORE WILL BE FLOATED TO POSITION AND SUNK ON PILE FOUNDATION



TUNNEL STARTS FROM HEART OF JERSEY CITY TERMINALS

York. Nine zones were laid out on each side of the river, and the distances from the center of each zone to each ferry and to the proposed tunnel entrances were scaled. Experimental time runs with a two-ton truck were made from the center of each zone to each ferry and to the proposed tunnel entrances.

Shows Saving for Tunnel

Data were collected on the cost of operating motor-driven trucks, based on average depreciation, gasoline at 17c. per gal., oil, tires and repairs. This investigation showed an average saving in time of 8.4 min. for each river crossing by tunnel, at an increased cost of operation, chiefly due to the added tunnel distance, of 5.18c. The calculation as to time distinctly favors the ferries by not taking into account the delays that are always incident to ferry service. A three-ton truck, valued at $10 per day, and a driver working 8 hr. for $4 per day would save 71.68c. per day, according to calculations. The total estimated number of vehicles crossing in the vicinity of the five ferries in 1920 is 3,998,620. It is believed that more than 60% will be motor driven and that at least 2,000,000 vehicles will use the tunnel if existent in 1920 in the location named.

London Tunnels Afford Information

London conditions are very similar to those existing between New York City and Jersey City. As long ago as 1798 a start was made on a tunnel to connect the north and south sides of the River Thames. Another tunnel was begun in 1805, but like the first, was abandoned. In 1825, work on a pedestrian tunnel was commenced and in 1843 completed. This, the first ever built by the shield method, is 1200 ft. long and consists of two arched passageways.

After several other attempts, the Blackwall tunnel, having an outside diameter of 27 ft. with an inside diameter of 24 ft. 3 in., was begun in 1892 and completed in 1897. The only ventilation is provided by the open ends and four vertical shafts covered with glass domed roofs, but having grilled openings directly beneath the dome, about 10 ft. high, and for the circumference of the shaft. The ventilation supplied by these openings, while inadequate today, is said to have been sufficient before the extensive use of the tunnels by motors. The Rotherhithe tunnel, completed in 1908, closely resembles the Blackwall tunnel, the principal difference being an increase of 3 ft. in diameter. In both cases the roadway is 16 ft. wide between curbs, and the maximum gradient is about 1 ft. in 37 ft. Traffic figures for the Blackwall tunnel show a falling off following the opening of the Rotherhithe tunnel, but in 1913, for which statistics are available, 772,940 vehicles used the tunnel, of which 38% were motor driven. In this same year 937,946 vehicles, of which but 9% were motor driven, used the Rotherhithe tunnel. Neither tunnel is used to capacity, and even in the maximum hour, when some 84 motor vehicles, 135 horse vehicles and 29 cycles and barrows passed through the Blackwall tunnel, there was no congestion. A study of traffic in these tunnels shows conclusively that a narrow tunnel roadway, properly policed, can accommodate two moving lines of vehicles and permit the passing of a vehicle going in the same direction, and that a speed can be maintained equal to, or perhaps exceeding, the speed maintained on an ordinary and much wider highway, for the reason that the flow of traffic is continuously in the same direction, with no vehicles joining or leaving the line, no cross-traffic, and no pedestrians to be avoided.

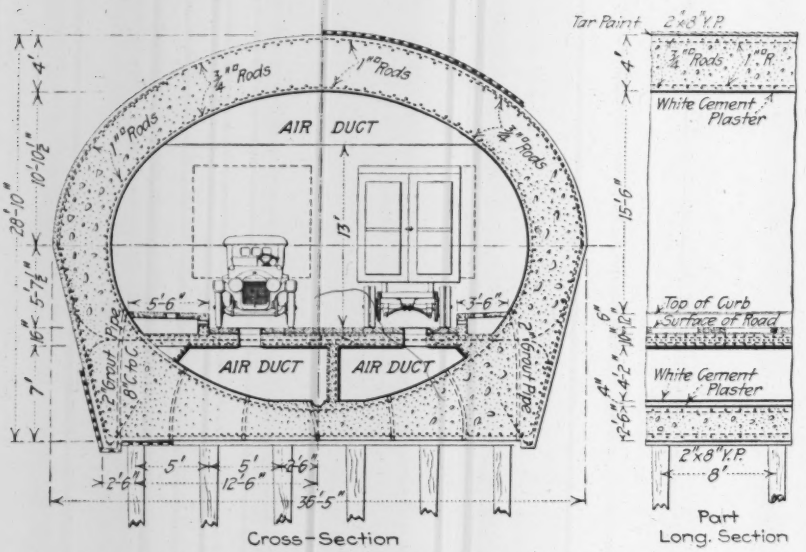
Ventilation the Big Problem

The ventilation of the London tunnels is distinctly bad, and it is quite evident that, with the increase in motor vehicles, artificial ventilation will shortly have to be provided. While unpleasant to breathe and trying to the eyes, ordinarily the air is not so thick that it interferes in any way with traffic; but on days of great humidity the air in the inner sections is so heavy with smoke and vapor that it is impossible to see an approaching vehicle 100 ft. away. Tunnel employees work continually in this atmosphere with no apparent ill effects, and there have been no serious prostrations, notwithstanding the passage of as many as 84 motor vehicles per hour through 1200 ft. of practically unventilated tunnel. This would indicate that, with proper artificial ventilation, a much larger number of motor vehicles could pass in safety.

The precise degree of vitiation that can take place in the air of a vehicular tunnel before the air becomes unsafe to breathe has not yet been determined. The principal products of combustion in gasoline-driven motors are carbon monoxide, carbon dioxide and smoke—due not only to the combustion of the gasoline, but also to the cracking of lubricating oil in the cylinders. Recent investigations in the ventilation of buildings have shown that any amount of carbon dioxide ordinarily generated in places where a large number of people congregate is not objectionable, provided the vitiated atmosphere is kept in motion. On the other hand, other recent investigations have shown carbon monoxide to be dangerous and that one of the principal functions of ventilation

is a dilution of that gas. Some investigators have concluded from their tests that the carbon monoxide should be diluted to the extent of 1000 parts of fresh air to 1 part of monoxide, but it has not yet been clearly established that a much less dilution will not accomplish all that is desired.

After having given extended consideration to the most recent and complete ventilation experiences, the board recommended the construction of a shaft 34 ft. interior diameter and 50 ft. high at either end of the river section of this tunnel for the introduction of fresh air by natural flow induced by the exhaustion of vitiated air, but supplemented by an additional volume for each end, blown



AIR DUCTS UTILIZE PARTS OF TUBE NOT USED BY VEHICLES

in by suitable fans through ducts of proper size built in the top of the tunnel and discharged within the central zone of the river section of the tunnel.

Differences of Opinion Exist

While it is the judgment of the board of engineers that the exhaust ducts should be placed in the bottom of the tunnel underneath the floor, investigations made by Prof. Gellert Alleman, of Swarthmore College, point to a rather different conclusion. For the purpose of studying the possibilities of artificial ventilation an air-tight building was constructed, 125 ft. long, as a model of a section of the proposed tunnel. The model section was filled with gasoline motor trucks and automobiles to the number of eight in all, and a series of tests made. Samples of air were taken at many points in the tunnel with all the cars running, both throttled down and racing, and with and without forced ventilation. During part of the tests air was introduced at the bottom, and further tests were made with the direction of the air reversed.

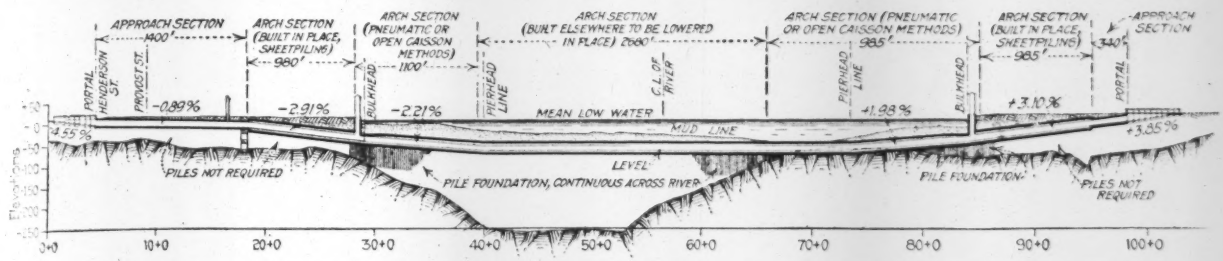
To quote from Professor Alleman's report: "It appears that the direction of the exhaust air is of considerable importance, the most satisfactory result being obtained when the air enters the tunnel at the bottom and is withdrawn at the top. This was to be expected, because of the fact that the exhaust gases leave the motors at a high temperature and are consequently lighter than the air and rapidly diffuse upward. . . . Some of the odors which are unpleasant are in no sense dangerous and are produced by the cracking of lubricating oil." This conclusion is based on the carbon monoxide content of the air samples withdrawn from the tunnel during the various tests.

The investigation of the possible traffic through the tunnel indicates that ventilation should be provided for 180 motor vehicles. A dilution of not less than 500 volumes of fresh air to one of carbon monoxide, based on the results of Professor Alleman's tests, will require a complete change of tunnel atmosphere about every 5 min., necessitating the introduction of 360,000 cu.ft. of fresh air per minute, which should be sufficient to produce entirely satisfactory ventilation. The best form of tunnel section for the accommodation of the traffic passing through it has received extended study. Obviously, the dimensions of the cross-sections must be sufficient and suitable to receive and pass freely, while going in opposite directions, the largest vehicles permitted to be used, and to provide sufficient room for the necessary air ducts. The board recommended that the vehicle of greatest dimensions to use the tunnel should be taken as having a width of 8 ft. and a maximum height of 12 ft. The illustration shows the final design. It is a hydrostatic arch section in which there is but little bending or flexure, the water pressure on all sides subjecting the material chiefly to compression in that part of the section above the floor. The lower part of the section is shaped to rest upon the top of the sawn piles. For each linear foot of this type of tunnel there are 16 cu.yd. of concrete and 2000 lb. of reinforcing steel. Under the worst conditions of loading assumed for the tube, the maximum compression in the concrete does not exceed 500 lb. per sq.in., while the maximum stress in tension in the steel reinforcement does not exceed 16,000 lb. per square inch.

The sectional method of tunnel building shown in the illustration has been employed successfully in the construction of the Detroit tunnel and of the new subway tunnel recently constructed under the Harlem River for the Lexington Ave. subway. When the ends of the tunnel section are closed by timber bulkheads, the tube may be floated, though it may require temporary attaching to suitable air cylinders to give it a requisite flotation.

War Department Sets Depth of Tube

The New Jersey Interstate Bridge and Tunnel Commission made application to the Secretary of War to fix the minimum depth, which, after consideration by the New York Harbor Board of Engineers and officers of the army, was set at 50 ft. below mean low water between the pier headlines. The elevation of the top of this proposed tunnel, therefore, had to satisfy that condition, though no conditions were prescribed for those parts of the tunnel between the pier head and bulkhead line on either side of the river. However, the tops of the subway tunnels under the East River are less than 30 ft. below water



WASH BORINGS AND TEST PILES DETERMINE ROCK PROFILE AT NEW YORK FOR FIRST TIME

at the bulkheads and have given some trouble in connection with dredging and other operations required for the maintenance of the bulkhead structures or for the berthing of vessels, so the board has considered it best to fix this depth at 33 ft. below low water at the Canal St. bulkhead.

These circumstances fix the maximum grades on the two approaches at 3.85% for the Canal St. approach, and 4.55% for the 12th St. approach in Jersey City, both being for short distances only, the prevailing grades being 3.16% and 2.21% respectively.

Piers and Rock Ledge Change Design

For a distance of about 600 ft. outside of the New York pier headline and for about the same distance back of that line, shallow rock excavation is required. For this part of the work and for other locations where dredging cannot be done without injury to adjoining structures, either the pneumatic process or open dredging—or a combination of the pneumatic process and open dredging—will be used.

Again, it is obviously impracticable, even with care, to excavate a trench with low side slopes between pier head and bulkhead lines without the destruction of adjoining piers. These parts of the tunnel will be constructed by the use of pneumatic or open-dredging caissons. In the use of the pneumatic-caisson method the working chamber may be so constructed as to form the top and sides of the tunnel tube, leaving the bottom of the tube to be built in the pneumatic working chamber after reaching the required depth.

Shield Method Shows Higher Cost

A comparison of cost of this tunnel with the cost of similar work successfully done by the usual shield method was made in order that the advantages of the sectional method of construction could be properly gaged. One of the latest tunnels driven by the shield method, and at the lowest contract price reached up to the present time, is the East 14th St. rapid-transit tunnel, consisting of two cast-iron tubes each 18 ft. in diameter lined with concrete 15 in. thick. The contract price for the two tubes was $937 per lin.ft. It is approximately correct to assume that the cost of two tunnels of different areas of cross-section built by the same process and under nearly the same general conditions will be about as the area of their cross-sections. The cross-sectional area of the two 14th St. tubes is 533 sq.ft., whereas the area of a circular cross-section 33 ft. in diameter, which would have the requisite vehicular clearances provided for in this tunnel, would be 855 sq.ft. Built by the shield method, its cost would reach nearly $\left(\frac{855}{533} = 1.6\right) \times \$937$, or $1499 per lin.ft., whereas the estimate of cost of the sectional tunnel designed by the board is about $765 per lineal foot.

Moreover, there is grave doubt whether a metal tube 33 ft. in diameter should not be of steel castings rather than cast iron, which would still further increase the cost of the shield-driven tunnel. The excessively large shields required for a tube of this size would be a source of greater difficulties and cost in consequence of its size and the great difference in depth below the water surface of its highest and lowest points. Finally, there would be a serious disadvantage due to a much greater depth of the roadway below water, necessitating either steeper grades for the approaches or a correspondingly greater length of tunnel.

Test Piles Driven

As the river section of the tunnel is to be placed with its top not more than 60 ft. below low water, it is imperative, to provide a foundation for this part of the structure of adequate carrying capacity. The profile of the river crossing indicates the necessity of using a pile foundation, as the material at no greater depth than the bottom of the tunnel at some points was found to be of silt and mud, too soft to be depended upon for the support of heavy loads as disclosed by the test piles and wash-boring examinations, which show a nearly uniform quality of silt and mud at the elevation of the bottom of the tunnel practically throughout the river section except for a distance of about 12,000 ft., as shown on the illustration. The completion of this part of the undertaking yields the first complete and correct rock profile under the Hudson River adjacent to Manhattan Island.

The greatest depth reached in driving the test piles was 133 ft. below low water. While these piles were not all driven to absolute refusal, they were driven until the penetration was so small as to be substantially refusal. It is probable, therefore, that piles 40 to 70 ft. long will be required for the general foundations. Studies that have been made of at least three methods of accomplishing this part of the work show conclusively that the foundation piles may be placed and cut off to accurate level and line to receive the tunnel sections directly upon them.

The maximum velocity of water to be encountered in the Hudson River on the location of this tunnel does not exceed about 3 miles per hour, whereas in the construction of the Detroit tunnel a current of 3½ miles per hour was encountered, and without the advantageous stages of dead water at high and low tide. Full consideration has been given both to the design of the ends of the separate tunnel sections and to the operations required for effective and safe completion of the joints in the finished tunnel tube.

Highest-Head Hydro-Electric Plant in East Is Being Built at Silver Lake, Vermont

Water Diverted by Low Earth Dam Is Carried by Wood-Stave and Steel Pipe to 3300-Horsepower Turbine—Side-Hill Construction Difficult

By W. E. CONNER
Hydraulic Engineer, Hortonia Power Co., Rutland, Vt.

THE highest-head hydro-electric development east of the Mississippi River, so far as the writer can discover, is the 670-ft. head employed by the Hortonia Power Co. at Silver Lake, Vt. This plant is of interest aside from its head, on account of unusual hydraulic conditions of the development and because the system of which it is a part shows the commercial possibilities in many of the smaller powers of the East.

Company Acquires Small Plants.

The Hortonia Power Co. started in 1915 with the acquisition of a few small hydro-electric and steam plants in actual operation. It holds the rights for several larger and more important undeveloped hydraulic projects and is building a transmission line, to be the backbone of the system, extending irregularly across the State of Vermont from Port Henry, N. Y., to Salisbury, Barre and St. Johnsbury, near New Hampshire. A large number of comparatively small stations will feed their energy into this transmission line, which reaches several locally important industrial districts.

Among the acquired projects was the Silver Lake development, which required the diversion of a brook to an isolated lake, converted to a storage reservoir, with the water let down through wood and steel pipes to the station and back into the lower reaches of the brook, 700 ft. below the point of diversion.

The first plans called for the diversion of Sucker Brook (see Fig. 1) at the confluence of Sucker and Dutton Brooks (at El. 1276), the construction of 3000 ft. of penstock or open flume and 3600 ft. of open canal to Silver Lake (natural El. 1241), construction of a dam at the north end of the lake, driving a tunnel through the mountain to the west and laying 2200 ft. of steel penstock to the power house located on the shores of Lake Dunmore (natural El. 571).

Changes were made after a careful investigation of existing physical conditions and cost of construction. The soil at the location of the 3600-ft. stretch of open canal

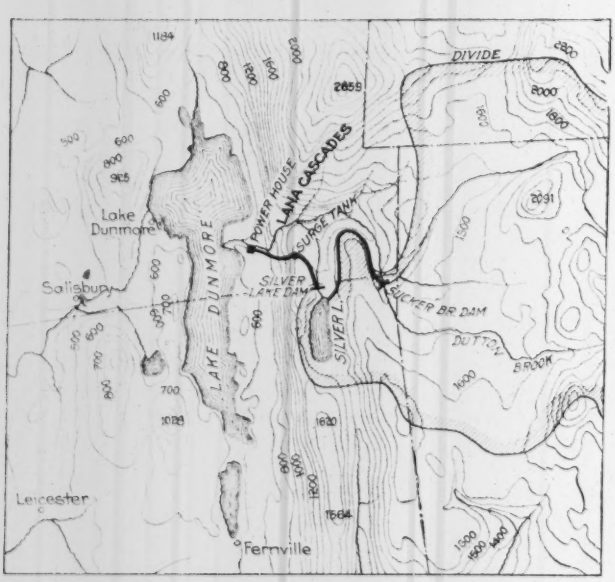


FIG. 1. SILVER LAKE DEVELOPMENT OF HORTONIA POWER CO. SHOWS POSSIBILITIES OF SMALL EASTERN POWERS

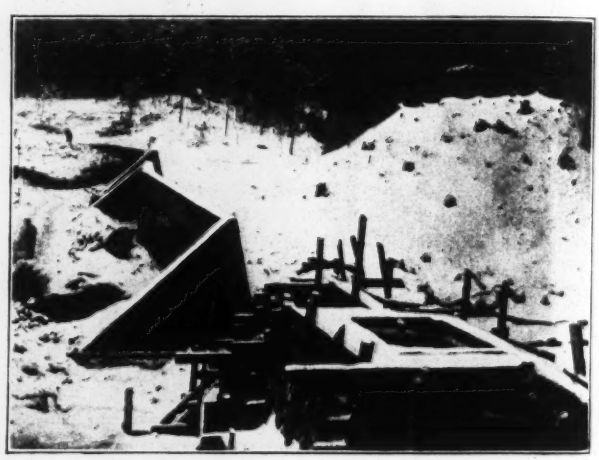


FIG. 2. DIVERSION DAM HAS SPILLWAYS FOR DIVERGING STREAM CHANNELS

was gravelly and too pervious to make good canal banks, and it was decided to run the diversion penstock the entire distance from the diversion dam to the reservoir. The tunnel through the mountain was to have been 7 x 7 ft. in cross-section and about 300 ft. long. Owing to the inaccessibility of the tunnel site, the cost was found prohibitive, so that a longer pipe line and a new station site were adopted.

The total drainage area above the diversion dam is about 20 sq.mi. The dam is an earth-fill with core wall; the crest is 230 ft. long and the maximum height 14 ft. The core wall has a top width of 16 in., with the downstream face vertical and the upstream face battered 3 in. per ft. Buttresses are placed at each end of the spillways—of which there are two. The spillway over Sucker Brook channel, 40 x 4 ft., was left 1 ft. lower (El. 1291) than that over Dutton Brook, 30 x 3 ft., because Sucker Brook has a larger drainage area and in order to induce a cleaning current away from the trash racks that are near the smaller spillway.

The diversion headworks are very simple. An 18 x 14-ft. trash rack, made from 2 x 4-in. oak strips spaced 2 in. apart, guards a triangular forebay. The gate opening

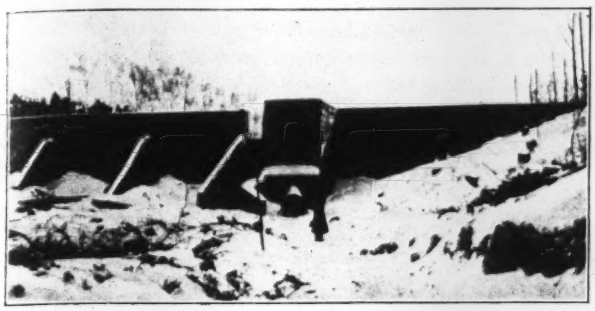


FIG. 3. SILVER LAKE DAM HAS BUTTRESSED COREWALL CONNECTED TO GATE CHAMBER

is 5 x 5 ft. and is closed by a simple plank gate in wooden guides. A small secondary forebay is placed between the gate and the pipe leading to Silver Lake. This line has an entrance head of 7.5 ft. At the present writing the dam is completed, with the exception of the two spillway sections, which were entirely omitted to accommodate freshets that might arise during construction.

The diverted water is to be carried first in a 60-in. continuous-stave wood pipe for 6300 ft., then in a 42-in. steel pipe for 700 ft. and finally in an open canal 375 ft. to Silver Lake. The pipe line is run on a grade of 1 in 1000.

Silver Lake Reservoir

Silver Lake is a pond of 120 acres. Its natural drainage area is less than 1 sq.mi.; there are no tributary streams, and it is fed entirely by springs. It is surrounded on all sides by high hills and is an ideal reservoir. The impounding dam erected at the outlet, or north end, is 285 ft. long and has a maximum height of 30 ft. It is of the same general type as the diversion dam, but has five buttresses on the lower side of the core wall. This last has a top width of 16 in. and a maximum width at the base of 6 ft. A 6 x 6-ft. cutoff wall runs under the entire wall below the natural ground surface. The spillway is only 10 ft. wide, as it is designed to care for only the flood waters of Silver Lake drainage area.

The control gates are placed in a 12 x 14-ft. forebay adjacent to and west of the spillway. A 6 x 6-ft. tunnel under the upstream fill carries the coarse rack (Fig. 4) at its upper portal and provides access to the gate chamber. Two 4 x 5-ft. gates control the inflow. A fine rack made up of 3 x ⅜-in. oak strips, ¾ in. apart, is placed over the end of the outlet penstock. A 3 x 4-ft. gate, to drain the rack chamber when the main gates are closed, is placed in the wall between the gate chamber and the spillway channel and just in front of the fine rack. The spillway (El. 1251) is placed so as to raise the surface of the lake 10 ft., giving an entrance head of 19.5 ft. on the outlet.

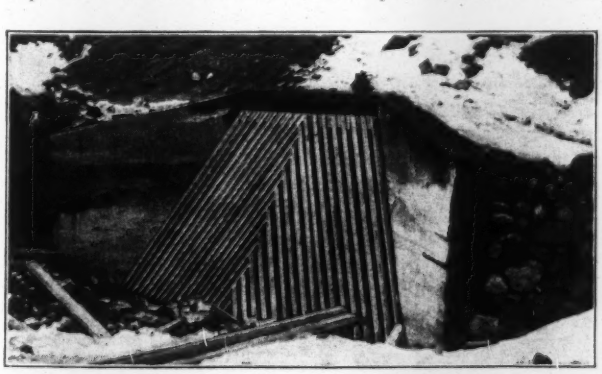


FIG. 4. COWCATCHER RACKS AT SILVER LAKE OUTLET ARE OF OAK

Penstocks and Station

From the reservoir a 60-in. continuous-stave wood pipe 2915 ft. long, laid on a grade of 1 to 100, will lead out to the steep mountainside descending to Lake Dunmore. A surge tank, 85 ft. high and 10.5 ft. in inside diameter, at the end of the wood-stave pipe, is to rest on a concrete foundation 14 ft. square and carried down to bedrock. It is to be of double-shell wood-stave construction, similar to a silo; the outside shell is simply a frost casing.

From the surge tank, at El. 1190, a 36-in. lock-bar steel pipe carries the water 2300 ft. to the power house (floor at El. 601). This line goes down over a very steep rock cliff, the slope in some places being as great as 45°. There are 14 concrete anchors, averaging 10 x 7-ft. bottom section, extending 2 ft. above the pipe. Besides these anchors, small supporting piers are placed under the pipe at intervals of about 20 ft. No expansion joints are provided, all movement being cared for at curves. This pipe is erected and ready for test.

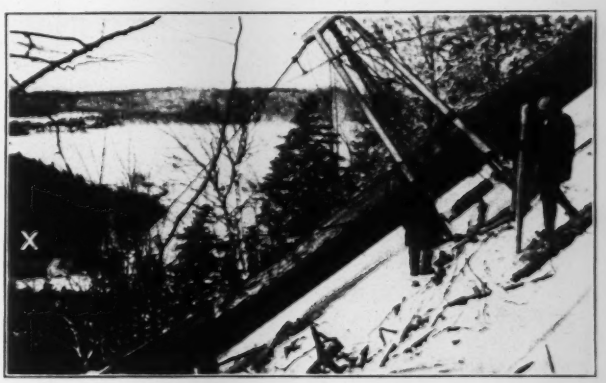


FIG. 5. ERECTING LOCK-BAR PIPE ON 45° SLOPE
X marks power house

The power house is located about ¼ mile back from the east shore of Lake Dunmore and near Sucker Brook. It is of brick construction, with concrete substructure and machine foundations and a wooden roof. It is 48 x 59 ft. in plan and 17 ft. in the clear from floor to crane beam. The steel penstock enters the power house under the main floor, in a basement over the tailrace. This basement contains the reducing header, a hydraulically operated gate valve and a governor-operated relief valve; it will also contain the heating unit for the station.

There is a single turbine—a horizontal-shaft Francis-type, developing 3300 hp. at 750 r.p.m. It has a governor-actuated relief valve of the needle type, placed in the throat of the header pipe between the gate valve and the scroll case. Baffle plates were necessary in the tailrace under the relief-valve discharge pipe. The draft from center of shaft to low tail water is 24 ft. Direct connected to the turbine shaft are two generators and two direct-connected exciters. One generator is a 25-cycle 3300-volt 1760-kw. machine; the other is a 60-cycle 13,200-volt 500-kw. unit.

Some very difficult side-hill work was encountered in making the first 2000 ft. of the grade for the diversion pipe. The natural slope of the ground was steep, and near the upper end wet and springy. The steep slope seemed to be maintained by the covering of roots and vegetation upon it. As soon as this covering was cut through and the scarf started on the side hill, the underlying material began to flow out from under it and run out over the grade. The surface above the ditch subsided, and trees fell across the line. In a few places large areas of the slope above the grade had to be cleared to relieve the covering of its weight and prevent landslides. At the present time this ditch is finished and ready for the wood-stave pipe.

The side-hill work on the steel pipe was difficult under winter conditions. The rock was covered with a sheet of ice, and the contractors had to string life lines over the face of the cliff, so that the men could get around.

The Hortonia Power Co. was organized, and has continued, with I. M. Frost, of Rutland, as vice president and general manager. The writer made the preliminary surveys and investigations and has continued as hydraulic engineer for the company. The turbines and governors were supplied by the Pelton Water Wheel Co., of New York and San Francisco, and were built in its Harrisburg shops. The generators, transformers and important electrical equipment were furnished by the General Electric Co., of Schenectady.

What Is a "Consulting Engineer"?

Indiscriminate Use of Title by Private Practitioners Held To Be Unjustifiable—A New Term Is Needed

By GEORGE C. WHIPPLE
Professor of Sanitary Engineering, Harvard University, Cambridge, Mass.

IN CONNECTION with the efforts being made to enhance the dignity of the engineering profession and to institute codes of ethics for the guidance of practitioners it seems to the writer that the propriety of using the word "consulting" before the word "engineer" as it is now used in professional cards should be seriously discussed.

What is a consulting engineer? Do the words mean the same as they did a generation or two ago? Is an engineer a "consulting engineer" when he is not being consulted? Does the term represent a state of willingness or desire to be consulted, the qualification to advise, or does it describe an actual service and cease to apply when the service has been rendered? Does it signify merely an engineer who maintains an independent office and is free to undertake engineering work for any client who comes? If so, by what other title shall be called the engineer engaged to advise or support a fellow engineer or to review his plans or work in order to assure some client that the plans are sound or the work well done? Is it ethical for an engineer to advertise himself as a consulting engineer, or is the use of the word "consulting" an affectation, an assumed superiority, a self-raised pedestal, a bait to lure the unwary client? Has the noble word "engineer" become so belittled that it is necessary to bolster it up with an adjective not descriptive of a special field of work, but merely indicating that the holder of the title is looking for a job? Or is the change merely a phase of the general movement to raise society by pulling down a higher title, a movement whereby the washwoman becomes a washlady, the music teacher becomes a professor, the plumber becomes a sanitary engineer? These questions are of more than academic interest.

Early Use of the Title

At the time when the writer left study and began work, in 1889, there were almost no consulting engineers—that is, engineers who styled themselves as such, if we may believe the membership lists in engineering societies and the advertisements in engineering papers. Engineers in private practice styled themselves "civil engineers," "hydraulic engineers," "sanitary engineers," or sometimes used combinations of these words. Here and there some one used the term "consulting engineer," but he was a *rara avis*.

In those days the consulting engineer was not the man who drew plans for an engineering work or who made the principal report to a state or city or some private client in regard to a given project. He who performed that service styled himself the engineer or, on large works, the chief engineer. In case special advice was sought or the plans or the project needed review, another engineer was called in consultation, and he was naturally called the "consulting engineer." In the old reports the engineer's report was full and complete; the consulting engineer's report could sometimes be printed on a single page. The consulting engineer's work was largely advisory, and those chosen for such service were naturally selected from the older, experienced men in the profession.

This use of the term corresponds with present usage by doctors and lawyers. Doctors do not advertise themselves as consulting physicians; they do not put that sign on their doors. Yet in serious cases physicians of special attainments or experience are called "in consultation." Lawyers get a large part of their living by being consulted by their clients, but we never see the words "consulting attorney-at-law" on a lawyer's shingle. Yet lawyers are often called in in an advisory capacity and are called "advisory counsel," an excellent term.

Change in the Use of the Title

It is difficult to say just when or just why the title consulting engineer began to be substituted for the other titles mentioned above. The new term was not conspicuous in 1900, but since 1910 it has been very common. Up to quite recently the professional cards of engineers in private practice appeared in some technical papers under the general heading "Directory of Consulting Engineers." We even have an American Institute of Consulting Engineers, a name which in the writer's opinion is a misnomer. It would be interesting if someone would compile statistics showing the use of this term, based on its occurrence in membership lists and advertisements.

Some of the first to use the term consulting engineers were engineers who had retired from official positions and who were prepared to act in an advisory capacity—and as a matter of fact did so exclusively, maintaining no corps of assistants and not undertaking to prepare plans or supervise the construction of work. Others who assumed the term were men who had been specialists and whose work at first was also advisory, but who afterward took up the preparation of plans and specifications and

all the other regular work of an engineer in addition to their advisory work. The development of the special field of sanitary engineering, coupled with the disposition to avoid the use of the title "sanitary engineer"—perhaps for fear of being regarded as a plumber—seems to have given the use of the title consulting engineer a great impetus. Many of the present-day consulting engineers not only do work which is strictly advisory, but also prepare plans and specifications, supervise construction and act as intermediary between client and contractor. Some of these take pains not to sign plans over the title of consulting engineer, but discriminate in their official use of the term between work which is advisory and that which is not.

Whatever the reason, we find that today the title of consulting engineer is assumed by more than half of the private practitioners, if we may judge by the professional cards in engineering papers.

Ought the Title To Be Used?

In the opinion of the writer the title "consulting engineer" is one which should not be *assumed* by any engineer, great or small, but should be used to define the status of an engineer on a particular piece of work or with reference to a particular client. This work may be of short duration or extend over many years, or an engineer may even be permanently employed as a consulting engineer.

If the term means that the engineer is willing to do only advisory work, there are few engineers today to whom it would fairly apply (the names of most of these gentlemen are conspicuously absent from the published lists of professional cards) and it is unnecessary for them to use it, as their reputation needs no artificial support. If it means merely that the engineer is in private practice, its true meaning is utterly lost and its use correspondingly unnecessary. If it means that the engineer regards himself as capable of advising or giving consultation, its use is attended with such opportunities for self-aggrandizement that it is undesirable. If it means that the engineer is a specialist in a particular field, its use is not as descriptive as the word specialist, accompanied by a statement of the specialty. Viewed from almost any angle, the use of the word as an assumed title is objectionable and detracts from the dignity of the word engineer.

The writer believes that if the older and more prominent engineers would drop the use of the title from their professional cards, the younger men would follow suit as a matter of course.

Older and Younger Men

There will always be these two groups of engineers, and both are needed. The young men should be given their chance; but if they assume responsibility at an early age, they should secure advice from more experienced men—otherwise, failures are liable to result, and the reputation of the profession as a whole will suffer. If such young men assume the title of consulting engineer, their clients will not favor the idea of calling in a second consulting engineer to advise the first. This situation would not arise if the title were not self-assumed.

To a certain extent this situation is being taken care of nowadays by the practice of the older men in associating younger men with them in a firm or company that is sometimes of considerable size, the older men presumably advising the younger in whatever work they undertake and the entire firm being styled consulting engineers. It must be admitted that this arrangement has decided advantages. But to apply the term "consulting engineers" to this composite body engaged in different grades of engineering work is inappropriate and confusing.

Is a New Title Needed?

The writer is of the opinion that either one of two courses should be followed—either the title "consulting engineer" should be given up as an advertising term and restored to its former meaning, or a new title should be created—namely, that of "advisory engineer" or some other term of similar meaning. This latter course is objectionable, for reasons that are obvious, chief of which would be an added complexity.

There will always be a place in the profession for men of special experience. The world will always need real consulting engineers. Why cannot the present confused situation be easily cleared if the engineers in private practice will style themselves "engineers" or "civil engineers," adding thereto a statement of their specialty or specialties, if any, leaving the title "consulting engineer" as one to be conferred upon them for a particular engagement?

In conclusion the writer wishes to state that he is a member of a firm that now uses the term "consulting civil engineers" on its letterhead and on its professional cards, but the firm will be glad to drop the use of the word "consulting" if a number of other engineers are disposed to indorse the reform.

New Type of Road Machine Needed for the Ozarks

That existing types of road machinery are not suited for the difficult conditions encountered in road work in the Ozark Mountain region of southern Missouri and that new machines of stronger construction and adapted to more digging are required is asserted by Prof. E. G. Harris, of the School of Mines and Metallurgy, University of Missouri, in a road bulletin just issued by the university. The difficulties encountered are the frequent beds of cemented clay and gravel, forming a real hardpan (which also contains occasional boulders), the equally frequent occurrence of ledge rock, the heavy grades on many of the roads and the variable depth of ditch. Road machines are now working in this region and are producing results that could not be obtained without them, yet something better is required by the local conditions:

"The life of the tools is short even when they are not broken. The depth of cutting necessary to get a side ditch varies much and is usually greatest where the ground is most difficult to work. Hence, it is necessary to run the machine over the road many times more than would otherwise be necessary."

The machine to be built for these conditions, Professor Harris holds, is a digger rather than a scraper or plow. It should be capable of digging out the hardpan, including boulders of considerable size and the lighter shells of ledge rock, and it should finish the ditch on one side in a single pass.

Large Concrete Caissons Sunk from Trestles

Unique Job at Grand' Mère, Quebec; Concreting Started on Suspended Platforms, Weight Shifted to Brackets and Screws, Caisson Lowered and Concreted

By C. H. COVEY
Fraser, Brace & Co., New York City

ONE of the most interesting pieces of caisson work in recent years was the building and sinking of six concrete caissons, 60 ft. long and 10 ft. wide, in the tailrace of the large hydro-electric station of the Laurentide Power Co. at Grand' Mère, P. Q. This work was done in 1916 as part of the strengthening of the station substructure following a change in plans to allow employment of a higher hydrostatic head. The tailrace piers were to be extended downstream, the additions being heavily reinforced horizontally and vertically. As two generating units were then running, the race could not be unwatered. The following notes show how the concrete caissons were built upon platforms between piled trestles, lowered by screws to the sloping bottom, sealed and filled with concrete.

Building the Trestles

The caissons were built and sunk one at a time. First, a trestle was built on either side of the caisson bed. The trestle consisted of two rows of vertical piles braced and capped. There were 14 piles in each inner row and 7 in each outer; they were set by means of a scow derrick, one at a time and weighted down with sand bags. There was not enough material overlying the bottom to permit driving. Each group of three was placed to form a triangular bent, and then these bents were in turn tied together, as shown in Fig. 3. The inside row of piles was cut off at an elevation depending on the elevation of the water in the tailrace, so as to have the bottom of the crossbeams under the caisson platform just out of water. The rate of lowering of water was carefully studied, so that the platform might be built at the lowest possible point.

After the piles had been cut off at the required elevation, they were capped, first with a 12 x 12-in. spruce timber running the whole length of the trestle and, above this, with a 10 x 10-in. hard-pine timber. The caps were drift-bolted to each other and to the piles. Across the top of each trestle 4 x 10-in. horizontal braces were run inside and outside of the piles. On these, 3 x 9-in. planks were laid edgewise longitudinally across the braces, about 16 in. on centers. On top of these in turn were 2 x 10-in. planks completing a working platform. The crossbraces were about 33 in. below the top of the 10 x 10-in. cap, which brought the top of the working platform about 2 ft. 9 in. below the top of the caps, giving a convenient distance for handling the wrenches used in lowering the caissons.

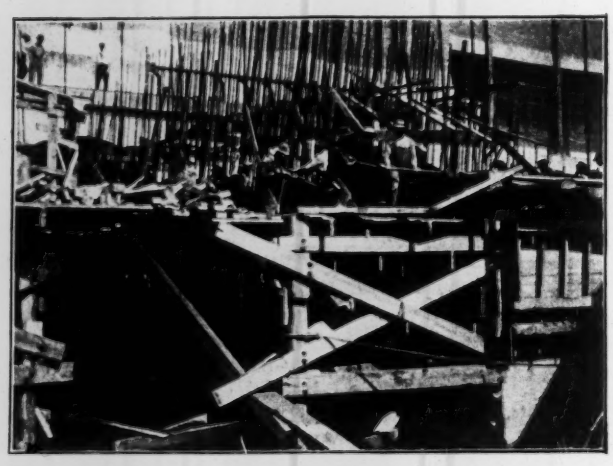


FIG. 1. LOWERING CONCRETE CAISSON AT GRAND' MÈRE
Men at lowering screws; cutting edge under water; forms in place for second lift

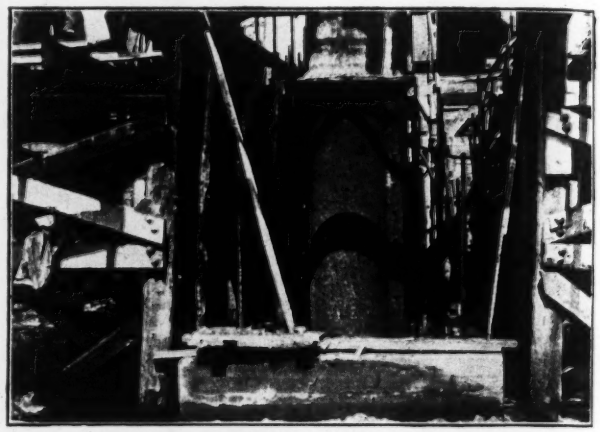


FIG. 2. CONCRETE CAISSON IN WATER READY FOR SECOND-LIFT FORMS

When two-thirds of the piles for one trestle had been set, work was started on the permanent bracing (above water by carpenters and below water by divers) and on the working platform. In this way a platform was completed about one-half day after the trestle was up.

Caisson Platform

As soon as the trestle caps were in position, they were bored on 2-ft. 3-in. centers for ¾-in. hanger rods to carry the caisson platform. The ¾-in. rods were put in place holding up 6 x 12-in. cross-timbers between trestles. Over the cross-timbers were 3 x 6-in. timbers laid lengthwise, and on top of these were 1-in. boards to carry the steel cutting edge and forms as shown in Fig. 3.

Then the cutting edge, a 6 x 6 x ⅝-in. angle, was placed on the platform and held in position by 2 x 4-in. and 2 x 6-in. pieces about 2 ft. long, extending toward the middle of the platform far enough to come over two longitudinal stringers. The outside forms were started, the reinforcing steel was set in the cutting section, and the inner forms for the working chamber were built. The outside forms were carried up to the top of the deck floor.

and the lowering brackets, reinforcing rods in the deck, counterforts, shafting, grout pipes, air pipes, etc., were put in position. Finally, the section was concreted to the top of the deck floor.

The brackets were made up of angles on a ½-in. plate. Across the bottom of the brackets was a 1-in. plate which had a threaded hole in the center, so that the lowering rod could be screwed in. In this bearing plate were four 1-in. holes matching with five ¾-in. holes in the bottom of the bracket, as shown in Fig. 3, so as to permit a considerable range of adjustment. The brackets were taken off (by divers) when each caisson was completed.

Two nuts were put on the end of the lowering rod under the plate, to avoid the possibility of the rod screwing out of the nuts during lowering. Filler plates were bolted to the brackets on either side of the lowering rods, so as to keep the bending, during tilting of the caisson, up in the maximum section of the rod where there were no threads. These lowering rods were all made of rolled steel and were cut with U. S. Standard thread, 4½ threads per inch, for the entire length except for a 2-ft. space extending from 6 in. above the lower end. On the cap at each lowering screw was placed a 10 x 10 x 1¼-in. plate with a 2¼-in. hole. Between this plate and the nut was a brass washer 7 in. in diameter, 1¼ in. thick and with a 2¼-in. hole.

After 24 hours had been allowed for concrete to set up, the forms were stripped. At the end of another 24 hours a strain was taken on the 2-in. lowering rods to relieve the ¾-in. rods holding the concreting platform. Then the platform was removed and the caisson was ready to lower.

The caissons were first lowered to a point where the top of the deck was about 1 ft. out of water, and the forms for the second lift were then started. Air was put on to the working chamber when the cutting edge was about 24 in. under water. As soon as the second lift had been concreted and set, the forms were stripped and the caisson was lowered until the cutting edge was just clear of the highest point of the tailrace floor. Drilling, blasting and mucking were then started inside the caisson, which was lowered as fast as the rock was taken out.

Tilting of the caisson began when the cutting edge got approximately into position on the high end. After the caisson had tilted nearly to final position, mudding up be-

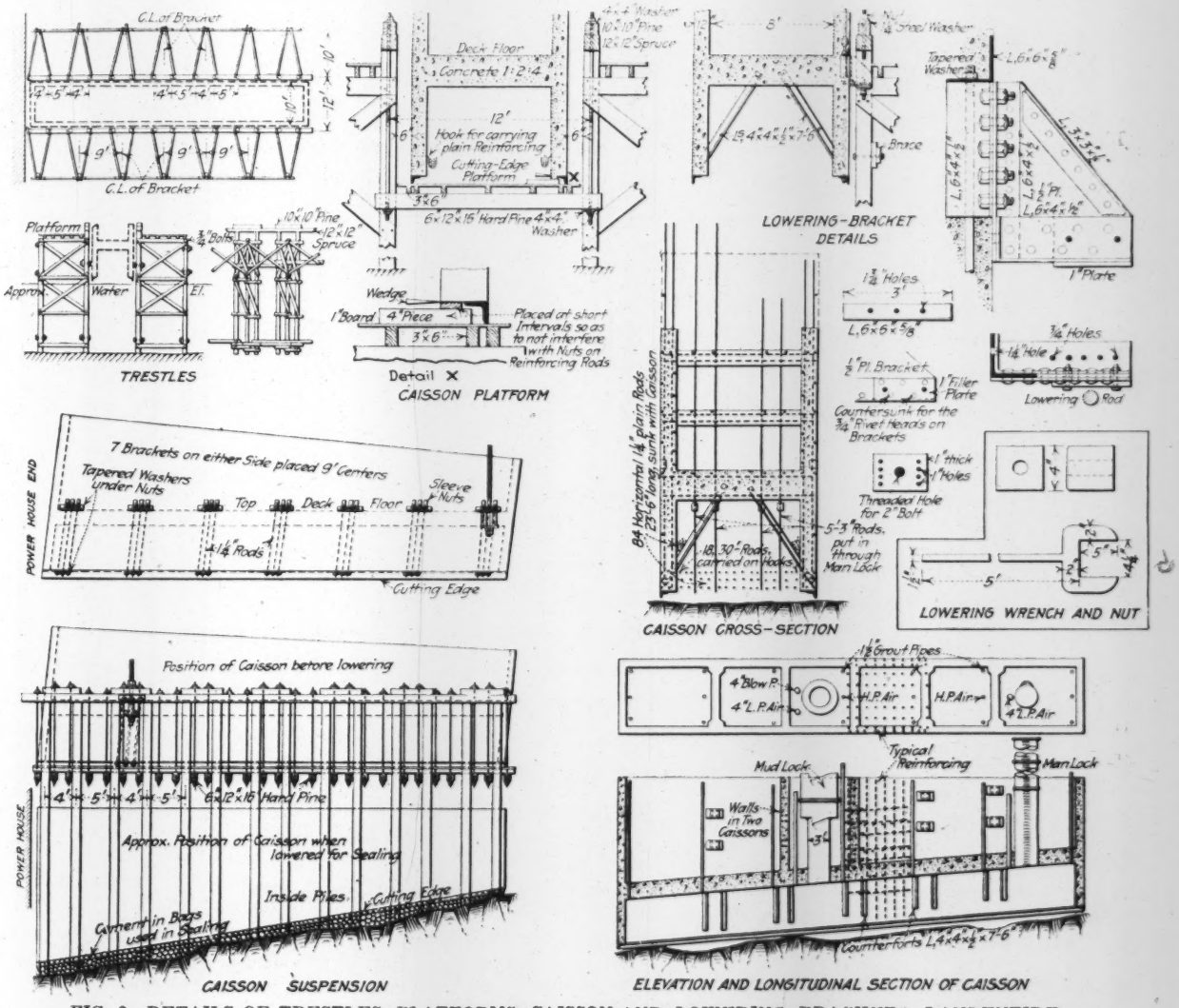


FIG. 3. DETAILS OF TRESTLES, PLATFORMS, CAISSON AND LOWERING BRACKETS, LAURENTIDE TAILRACE PIER EXTENSIONS

gan at the high end. This process consisted of placing clay in bags under the cutting edge and mudding up the voids with clay. This continued toward the low end until the water could be kept down to a point low enough to remove all the necessary rock. When this was done and the caisson was in final position, the sealing began.

The sealing consisted of removing a bag of clay and replacing it with a bag of cement. The voids were plastered up with cement. After the sealing was completed, the reinforcing rods (which had been brought down on hooks in the working chamber walls and on the counterforts) were placed, and the working chamber was ready for concreting.

The working chamber was concreted up to within a few inches of the top and allowed to set overnight. Air was taken off, and 1:2 grout was put in. Air was then put on to blow out any water in the chamber. As soon as the grouting stood 4 or 5 ft. in the shafts, a neat cement grout was poured into the 1½- and 4-in. pipes until the pipes were full. The upper portion of the coffer was then cleaned out and concreted, which finished the caisson proper. A thick, reinforced slab connecting the piers was placed over the caissons to complete the work.

Miscellaneous Notes

The total weight of caisson hanging free was estimated at 670,000 lb. The method employed reduced this weight so that the unit stresses in hanger bolts on lowering rods was kept within the allowable limit. In order to make speed, however, two caissons were built by concreting two lifts at a time. In these cases 26 lowering rods were used instead of 14, and a strain was taken on the lowering rods before the second lift was poured, thus removing the excess strain from the 7-in. hanger rods carrying the caisson platform.

In all caissons but two, crossbeams were used to strengthen the sidewalls of the upper portion, but more or less trouble was incurred at the time of changing the mud lock for the concrete lock. The mud-lock shafting was so short that, when the cofferdam was filled with water, the connection of the lock and shafting was under water, making it necessary to pump the water down to change the locks. This operation of pumping down took place about the time the caisson was sealed, so that with the water pumped out to a point where the lock could be taken off enough weight had been removed from the caisson so that the caisson would lift a little off the seal under the 9 lb. of air required at this stage. To eliminate this damage and delay, in the last two caissons walls were put in 1 ft. thick in place of the concrete beams on either side of the mud locks. These walls made it possible to pump the section around the lock dry without pumping out the water in the other section. It also made it possible to clean out one portion of the coffer and start concreting while the other sections were being cleaned out.

Construction Plant

Three locks were used on each caisson—a man lock, a mud lock and a concrete lock. Each consisted of vertical shafting with a diaphragm and door on the top and bottom. The concrete lock took the place of the man lock when the caisson was cleaned out.

A reciprocating compressor, with a capacity of 1223 cu.ft. of free air per minute, was used. The compressed air was taken from the machine by a 6-in. air main to the working platform of the trestle and there connected by two 4-in. rubber-hose connections to the pipes running through the deck of the caisson. The 6-in. line was connected for emergency purposes to the Laurentide company's main by a 6-in. reducing valve that brought the pressure down to the desired value at the caisson. The 6-in. low-pressure air line was fitted up with a safety blow-off valve, which could be regulated to maintain the desired pressure.

The work was done by Fraser, Brace & Co., of New York and Montreal, represented by J. H. Brace, with R. B. Norris as superintendent and the writer as contractor's engineer. H. S. Slocum was resident engineer; the chief engineer of the Laurentide company during the completion of the power station, and since, was E. B. Wardle, of Grand' Mère.

Broken Old Concrete as Aggregate for New Paving Foundation

Present Practice in the Repaving of Kansas City Streets is Justified on Engineering Grounds

By CLARK R. MANDIGO
Consulting Engineer, Western Paving Brick Manufacturers' Association, Kansas City, Mo.; Formerly Assistant City Engineer of Kansas City

THE Engineering Department of Kansas City has been criticized by property owners and engineers alike for allowing old concrete foundations to be broken up and used as the coarse aggregate in mixing the concrete for a new paving base. In view of the fact that practically all the old foundations used in this way were made originally with a weak natural cement, there is apparently all the more reason for this adverse criticism. The Engineering Department believes, however, that this practice conforms to good engineering principles and will be approved when all the circumstances are considered.

The subsoil in Kansas City is a heavy "joint" clay, underlain with limestone at varying depths. It is almost impossible to drain it, and at best it lacks uniformity in bearing power. Prior to 1912, pavement foundations were laid 4, 5 and 6 in. in thickness, while natural cement was used prior to about 1907.

Old Foundations Poor

Chiefly on account of these poor foundations, and the heavier traffic, it was a difficult matter to keep pavements in repair on the main traveled streets during the normal life of the surfacing. Because of increased loads and speed of motor trucks, it was thought that a much more massive foundation would be desirable. An increased thickness of base would decrease the vibration under swiftly moving loads; and even if a poorer concrete was used, its ability to distribute the load and span soft spots in the subgrade would still be as great as that of a better grade of concrete of less depth.

Some of the old paving foundations had been built up of two courses, when asphalt had replaced old cedar blocks, for example; and although these bases were probably heavy enough, they were very uneven in surface contour, off grade, and badly cut up for conduits and service connections. By using the old broken concrete as aggregate in the new concrete base, the expense of hauling all this

old material to the dump and the cost of new broken stone would be saved.

The old concrete necessarily had to be broken into chunks small enough for a man to handle, and the additional cost of breaking these pieces by sledges into 2- to 2½-in. size cost but 30 to 50c. per cu.yd. additional. A 6-in. base would yield enough aggregate for a new 8-in. base. The cost of hauling old material to the dump would have been at least 40c. per cu.yd., and new crushed stone would have been $1.50 per cu.yd., delivered on the street, so that there was a saving of about 35c. per sq.yd. in the cost of the foundation.

An 8-in. foundation could be constructed, using old material, for about the cost of a 6-in. base using new crushed rock. Even allowing a 25% decrease in unit strength of the concrete, the 8-in. base would be as strong as the 6-in. base and have the additional advantages of greater mass and of distributing the load over a greater area of subgrade.

Specifications Control Size of Aggregate

The specifications for this class of work called for breaking the old concrete to 2½-in. size, screening it, if necessary, over a ½-in. screen and keeping it clean. Some of the old concrete could be plowed up or spiked with the roller. It was then broken with sledges as it lay, forked into wagons and hauled to the cross-street from which the mixer was to work. Other foundations were barred up, the chunks removed to cross-streets and there broken by one-armed, one-legged or old men, with short-handled mauls. It was usually forked from these piles into wheelbarrows, to remove the fine material and avoid screening.

In the past three or four years a great number of business streets in Kansas City have been repaved, using wood block, asphalt, stone block, and brick laid on new foundations, 8 in. thick, constructed as above described. The work has been carefully done; numerous field samples of the concrete have been taken and tested, and with one or two exceptions, excellent work has resulted.

Table I contains all the tests that have been made on concrete where old broken concrete was used as aggregate. Concrete taken from that actually going into the pavement was placed in twelve 8x16-in. cylindrical cast-metal molds, allowed to harden on the street and then taken to the laboratory, where it was stored under water of about constant temperature until ready for testing. The concrete was a 1:3:6 mixture. Table II gives the results of tests of 1:3:6 concrete for paving foundations, using freshly broken local limestone. By comparison the following results are obtained: Average unit compressive strength at 90 days, using broken concrete as coarse aggregate, was 1312 lb. per sq.in., and using freshly broken limestone as coarse aggregate, was 1299 lb. per sq.in.

Samples of all classes of concrete are taken on public-improvement work from time to time to check inspectors and contractors and determine how best to improve the work. The effects of this policy are shown in the table in the gradual increase in strength of concrete each year. Practically all the tests were the average result of crushing three samples. The seven-day test shows nothing of importance. Much depends on the time of year and weather conditions when the samples were made. In the other tests the variation in strength is no greater than

TABLE I. TESTS OF 1:3:6 CONCRETE MADE OF BROKEN OLD CONCRETE FOR AGGREGATE

Test No.	Date Sample Made	7 Days; Lb. per Sq. In. Compressive Strength	28 Days; Lb. per Sq. In.	90 Days; Lb. per Sq. In.	180 Days; Lb. per Sq. In.	Remarks
200	6-18-1913	500	750	1,023	1,065	1,470 lb.; 360-day test
201	8-28-13	353	673	1,003	1,133	Much fine material, also dirty
202	9-24-13	257	280	503	787	Wet, muddy subgrade. Large pieces and dirty
203	10- 6-13	690	640	887	1,687	
205	10-13-13	730	997	1,403	1,763	
206	10-23-13	463	630	867	1,097	Much fine material and some dirt
207	10-30-13	250	907	1,260	1,210	Cold weather when made
211	7-31-14	944	1,073	....	1,290	
212	3-27-15	640	1,260	1,811	1,823	
213	3-29-15	474	896	1,520	1,453	Green at 28 days
214	6- 7-15	880	1,380	1,580	1,786	
215	6-17-15	657	1,040	1,367	1,510	
216	6-29-15	777	1,220	1,767	1,710	
217	7- 3-15	277	573	657	1,116	Not properly screened; considerable sand
218	7-17-15	927	1,020	1,513	2,066	
219	8- 5-15	940	1,170	1,120	2,100	
221	8-30-15	847	1,280	1,283	1,830	
222	10-21-15	813	1,030	1,213	1,350	
223	11- 6-15	....	1,403 (32 days)	2,093	....	
224	8- 8-16	1,017	1,650	2,069	....	
225	11- 2-16	468	789	....	....	
227	11-15-16	390	783	....	....	
228	11-17-16	710	1,107	....	....	
229	11-21-16	507	1,170	....	....	

TABLE II. TESTS OF 1:3:6 CONCRETE MADE OF FRESHLY BROKEN LOCAL LIMESTONE

Test No.	Date Sample Made	7 Days; Lb. per Sq. In. Compressive Strength	28 Days; Lb. per Sq. In.	90 Days; Lb. per Sq. In.	180 Days; Lb. per Sq. In.	Remarks
204	10- 8-13	290	543	1,053	1,597	Coarse and slabs
208	11-21-13	363	1,250	1,463	1,770	Mixed with some old broken concrete
209	5- 6-14	585	1,050	1,155	....	
210	6-17-14	700	830	923	1,080	
220	7-21-15	580	923	1,666	1,645	
226	8-21-16	888	1,217	1,533	....	

is usually found from field samples where there are different street conditions, inspectors, contractors, equipment, etc. The sand in all cases was of good quality.

Results of Tests

These tests show that, if properly broken, forked and comparatively free from fine material, the old broken concrete foundation makes practically as good a coarse aggregate for concrete in paving foundations as where local freshly broken limestone of medium quality is used.

There is probably much to be gained in getting good results by watching the time of mixing, amount of water and manipulation of the concrete, and it is probable that both the inspector and the contractor were more painstaking when using the poor aggregate than when they had new material—a fact which may easily account for the practically equal average unit strength.

The variation between samples from different streets is much greater than the variation between concrete of different aggregates, all supposed to be mixed and placed under the same specifications.

There is no doubt an engineer would reject old broken concrete as coarse aggregate on visual inspection. The mortar lumps coating the rock are porous, easily broken and soft. The test cylinders show, however, that, whether new rock or old material is used, the strength depends almost entirely on the strength of the fresh mortar and not on the coarse aggregate.

In view of the field tests, the economy of construction, the extra thickness of base and the apparent impossibility of properly controlling all the other factors of mixing and placing concrete under average street conditions, the present practice in Kansas City in repaving work is considered to be justified on engineering principles.

Second Test of Seattle Flat-Slab Warehouse Shows Some Decrease in Stresses

Official Investigation of Mushroom Flat-Slab Floor by Building Department with Load Carried to 1.33 Times Design Load

ABNORMALLY high stresses in the mushroom flat-slab floor of the Bell St. warehouse tested by the Building Department of Seattle, Wash., in April, 1915, led to the making of a second test in August, 1916. The results of the first test were reported in the *Engineering Record*, May 13, 1916, p. 647, and in *Engineering News*, May 25, 1916, p. 992. Exception to these results was taken by C. A. P. Turner and Capt. A. O. Powell (the designers of the building) on the ground that the concrete had not sufficiently cured and that some of the steel reinforcement was misplaced.

Accordingly, a second test was made after the building had been in use for more than a year. This test was conducted for the Seattle Building Department by D. E. Hooker, assistant superintendent of buildings, and H. E. Fowler, structural engineer of the department. Mr. Turner was represented by V. L. Fixen, who took independent extensometer measurements. The following abstracts of the report made by Mr. Hooker to the superintendent of buildings are supplemented by abstracts from comment sent to this journal by C. A. P. Turner, of Minneapolis.

The test area comprised four continuous panels of the same (third) floor slab previously tested and occupied with respect to the former test area the position shown in Fig. 2. All the area of the four panels was loaded except for certain spaces around the three columns where the gage lines were located. The loading material was ore concentrates and cement in bags. Every truck load was weighed, and the required computed amount of load was placed on each quarter panel, within an error less than the weight of one sack.

The load was placed in three increments. The first increment amounted to 250 lb. per sq.ft.; the first and second increments amounted to 500 lb. per sq.ft., or just the design live-load; and the three increments totaled 860 lb. per sq.ft. This latter amounted to 1.72 times the design live-load, or 1.33 times the design live- and dead-loads combined.

Readings of all gage lines were taken after placing each increment of the load. Final observations were made about 14 days after the slab was entirely emptied. Independent readings were taken by three observers, and the results checked very closely.

In computing the stresses that are shown on one of the diagrams, the same elastic moduli were used for the steel and the concrete as were assumed in the first test. These were 29,000,000 for the steel and 2,500,000 for the con-

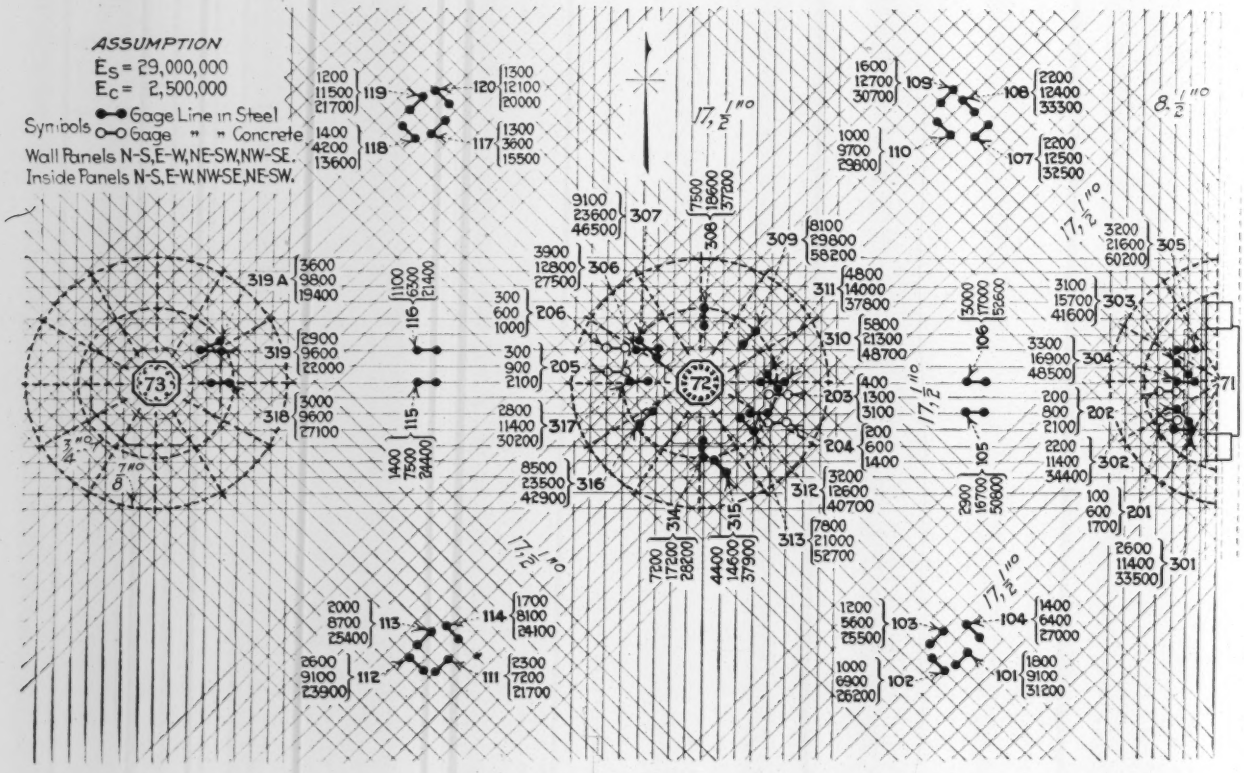

ASSUMPTION
Es = 29,000,000
Ec = 2,500,000
Symbols Gage Line in Steel
Gage " " Concrete
Wall Panels N-S, E-W, NE-SW, NW-SE.
Inside Panels N-S, E-W, NW-SE, NE-SW.

FIG. 1. GAGE POINTS AND STEEL AND CONCRETE STRESSES FOR THREE LOADINGS OF SECOND TEST OF BELL ST. WAREHOUSE IN SEATTLE, WASH.

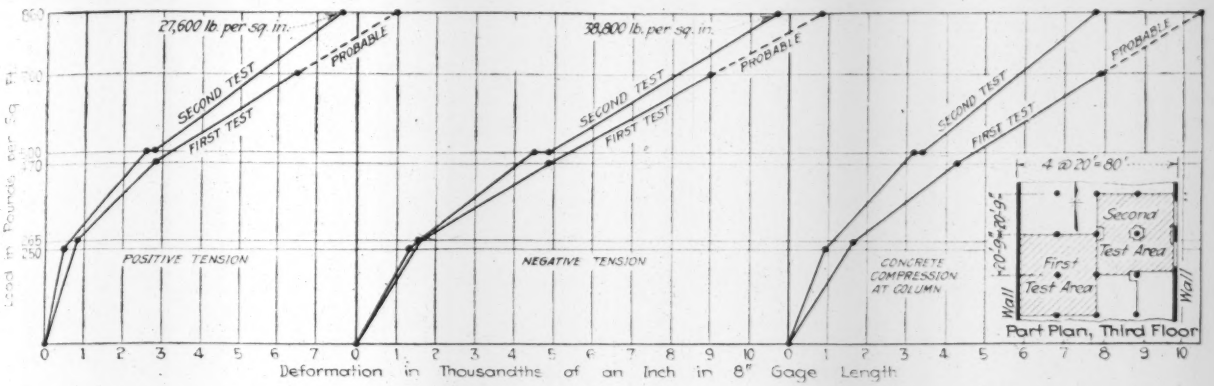


FIG. 2. DEFORMATIONS IN STEEL AND CONCRETE AT CRITICAL POINTS OF FLOOR

crete. This seemed necessary in order to make a definite comparison between the results of the two tests. In regard to the elastic modulus of the concrete, however, tests made of a 10-in. cube cut out of the floor at the time of the second test indicate a modulus considerably higher than that assumed in the first test. The cube was first tested in a 200,000-lb. machine, which failed to break it; several weeks later it was crushed in a larger machine and gave an ultimate strength of 3780 lb. per square inch.

The modulus for the second test was 3,820,000, or 53% more than the modulus assumed in computing the stresses indicated by the observed deformations in the floor slab. However, from the results of testing but one specimen and in the absence of time tests conforming, as to rate of application of load, to the conditions that obtained in the floor test, the assumption of a higher modulus was not considered justifiable.

Stress Results and Cracks

The stresses in the slab at each gage line, as computed from the observed deformations, are shown in Fig. 2. For each gage line three stresses are given, respectively for one, two and three increments of the test load. These stresses are those caused by the test load only and do not include any stresses due to the dead weight of the slab itself. Approximately 24 hours and again 72 hours after the second increment was placed and before the application of the third increment was begun, additional readings were taken, which disclosed continuing deformations under the constant load of 500 lb. per square foot.

Many cracks in the slab became noticeably evident upon placing the second increment of the load. In the top of the slab the cracks extended approximately along the center lines of columns, in both directions, merging visibly at the columns into others which extended around the columns. The largest crack, like that in the first test, extended for the full width of the two panels along the edge of the slab at the wall. This crack, which was about $\frac{1}{8}$ in. wide at maximum, is seen in the accompanying view (Fig. 3). Some cracks around the center column visibly extended down into the slab beyond the fourth, or deepest, layer of steel.

On the under side of the slab a large number of cracks seemed to develop in a well-defined pattern, consisting of bands of parallel cracks crossing column center lines at right angles and, as they approached panel centers, diverging to merge into other similar cracks, visible or invisible, which approached them at right angles from either side. The largest ceiling crack extended out diagonally from a wall column at a corner of the loaded area, about halfway to the panel center, then turned and became one of those in the band of cracks parallel to the wall. This crack had a maximum width of about $\frac{1}{16}$ inch.

Deflection and Wall-Column Stresses

The maximum deflection observed, 0.94 in. under full load, occurred at the center of one of the wall panels. The average recovery of the slab after unloading amounted to about 60% of the total deflection observed under the full test load.

Pronounced tension on the outside of the center wall column, about 2 ft. below the ceiling of the loaded slab, and corresponding compression in the same region on the inside of the column were noted from deformations measured in the vertical steel of the column at the locations mentioned. The maximum tension amounted to 13,350

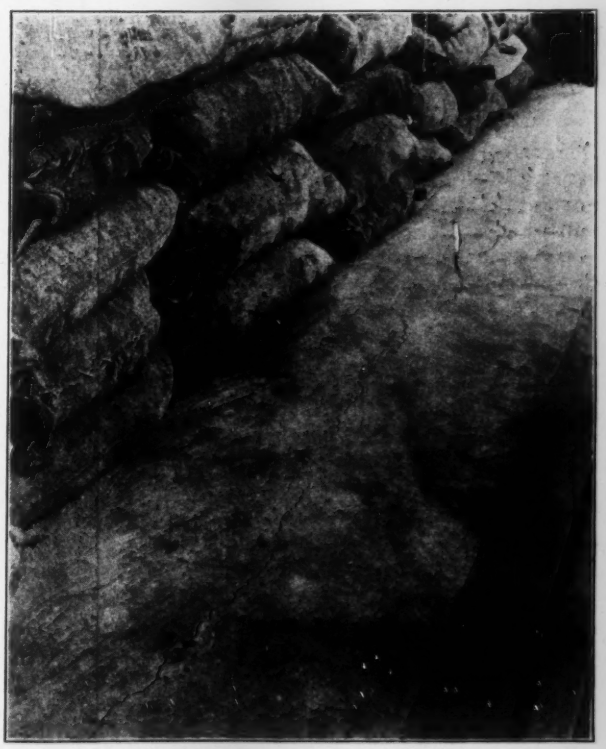


FIG. 3. CRACK IN FLOOR NEAR WALL BEAM

lb. per sq.in. and the maximum compression to 11,170 lb. per sq.in., caused by the test load of 860 lb. per sq.ft. Near the floor below the loaded slab the stresses were very small. No measurements were made in the column above the loaded floor.

Comparison with First Test

To make a comparison of stresses in the two tests, only a few gage lines of the first test, which were located correspondingly to those of the second test, could be used. Averaging the stresses of such selected gage lines and comparing the resulting averages with those of all the gage lines of the second test the results illustrated in Fig. 2 were obtained.

It is found that, had the loading of the first test been carried to 860 lb. per sq.ft., the average stress in the positive steel would probably have been about 18% and that in the negative steel 10.8% more than in the second test. A similar comparison for concrete stresses shows that in the first test the negative compressive stresses would probably have exceeded those of the second test by 34.6% at a load of 860 lb. per square foot.

In connection with the foregoing comparisons, however, it should be borne in mind that the intensities of the stresses in a slab vary rapidly at critical areas; hence, it is not entirely conclusive to make comparisons between gage lines that were not located necessarily at exactly the same relative positions in the slab. Nevertheless, the conclusions suggested by the foregoing comparisons are probably approximately correct.

In the first test, the top finish over the test area had not yet been applied to the rough slab. This top finish, probably averaging about 1 in. in thickness, may have increased the strength of the slab somewhat. Also, the steel in the second test may not have been so badly misplaced as in the first test. The survey for steel was not as thorough in the first test, but it is known that at least around the wall column the steel was misplaced more than at the corresponding column in the second test.

Conclusions and Recommendations

Mr. Hooker concludes that the slab is materially weak in negative steel, both at the wall columns and the interior columns; that it is weak in positive steel throughout the wall panels and particularly in the direct bands between columns; and finally, that the negative compressive stresses in the concrete near the columns were entirely too high. The slab is not well balanced as between wall panels and interior panels, nor even as to different portions of a given panel.

Disregarding entirely the weight of evidence that the computed stresses constitute, the visual effect of the comparatively small loads on the slab was enough to condemn it. Defects in the method, or lack of method, of holding the steel in place, coupled with the results experienced because of these defective methods, make it evident that reasonably correct placement cannot be relied upon.

In the light of all the evidence, it is recommended by Mr. Hooker that the building department disapprove of the "mushroom" system for future use in Seattle, unless altered so that it will check according to approximately the same requirements that have been imposed by the Building Department upon other four-way systems.

As to the Bell St. warehouse, it is recommended that the floors and the roof be approved for three-fifths of the live-loads for which they were respectively designed, with the reservation that, should the construction deteriorate due to continued use, settlement or other causes, such approved loads should be further reduced.

Comment by C. A. P. Turner

C. A. P. Turner was given the opportunity to comment upon the foregoing report, and the following abstracts are taken from his extended reply:

Mr. Hooker's report affords a sufficient justification for the exception taken to the first test on the ground that the concrete was not thoroughly cured, as it shows a decrease that he assumes to amount to more than 34% of the concrete deformation. The writer would estimate this decrease at 45% of that of the second test, by comparing the deformation under 700 lb. in the first test with the curve of deformation drawn smoothly through the observed points of the second test. In like manner it appears that the decrease in steel deformations is greater than that which Mr. Hooker gives.

The measurement of steel deformations is affected by the curvature of the rod, as, for instance, where there are any kinks followed by straightening of the bar under stress or by bending of the bar with the bending of the floor slab, as well as by temperature effects and shrinkage stresses in the concrete during curing or hardening of the slab. Any attempt to interpret the readings directly by multiplying the original observed readings or distances measured under the application of the load involves each and all of these various errors, which for scientific accuracy should be eliminated.

Whether there has been permanent axial set of the steel or not will be indicated by the comparative recovery of the steel on removal of the load rather than by the magnitude of the total original deformation. The effects of straightening kinks in small rods or of the curvature of these bars due to deflection and to such inequalities in stress as may be brought about by shrinkage will also be largely eliminated by considering the recovery on removal of the load rather than the original deformation under the first application.

Actual Stresses Based on Total Recovery

Any lack of recovery for deformations below the proportional limit cannot be due to permanent set, but must be due to the straightening of kinks or to axial changes of direction of reinforcing bars by bending. Especially is this the case when the stresses in the steel are as great as 16,000 or 18,000 lb. per sq.in., as no tensile resistance can be ascribed to the concrete. But by a detailed investigation of the observations the percentage of recovery is found to be smaller for low stresses than for high stresses. It is therefore wholly impracticable to rely on initial deformations for reliable indications of actual stresses in the steel. The total recovery is the only datum available for that purpose.

Although observations on the recovery of the steel on removal of the load were made by both Mr. Fixen and the observers for the Seattle Building Department, these important data do not appear in the report by Mr. Hooker. The percentage of recovery is found to vary from 48 to 67% for points 101 to 120 inclusive, excepting 105, 106, 115 and 116, or an average recovery of 56.3%, leaving a residual of 43.7%. All the corresponding stresses are low. The highest, gage 108, is only 33,000 lb. per sq. in. for a

recovery of 52%, while gage 102 shows 48% recovery with a unit stress computed in this manner of 26,200.

A repetition of the loading of the panels first tested would have given data of far greater scientific value than those obtained in this second test, which is, Mr. Turner maintains, clearly misleading as to the magnitude of the stresses and without verification in the data presented in Mr. Hooker's report. The conclusions arrived at by Mr. Turner after an extensive study of the test results are:

1. That true axial stresses in the bars did not exceed in this test the product of the measured recovery deformation of the steel times the modulus of elasticity of the steel.

2. That on this basis (because of the displacement of the steel) the stresses were 20% higher than desirable for the rated capacity.

3. That for the same reason it would be reasonable to reduce the capacity of the floor in the wall panels where the wall columns are long and not supported by the negative bending moment of the outside bridge, by the same amount of 20%.

4. That it would be unreasonable to consider it necessary to reduce loads elsewhere, because the stresses are not there excessive.

5. That even were the steel in place exactly as designed, the margin of surplus strength that it has been the custom to provide was reduced by an estimate of the relative rigidity of the wall column, the influence of which has been found greater than it was judged to be at the time of approving these plans.

Adjacent Towns and Cities Should Plan Together for Development

At the recent conference on city planning in the Metropolitan district of New York, George B. Ford, of New York City, read a paper which contained a discussion of coöperative city and town planning. The gist of that discussion follows:

No growing town can afford to stop planning at its corporate limits for, just outside those limits, streets are being laid out and buildings erected contrary to the city's interest. A little coöperative planning now would save the spending of vast sums of money later to correct the troubles.

In the New York metropolitan area, where there are so many cities and towns close together, often bordering on each other, everyone that has done any constructive planning realizes how difficult it is to size up the trend of future growth in his town, unless he knows how the neighboring towns are going to be planned. A comparatively small change in almost any phase of the planning of the next town may easily make a serious difference in the case of his town.

It makes considerable difference where main traffic thoroughfares or electric cars enter a town; in fact the thoroughfare system of the town and the layout of the street car system is quite dependent on them. If one town succeeds in relocating or depressing or elevating a railroad, the adjacent towns have to plan to conform. If a railroad station is located near the border of a town, the nearby streets and car lines in the next town are altered to fit. A good park on the edge of one community has a strong influence on the park situation of the adjacent community. Bad housing "just over the line" brings up serious planning problems. Different planning laws and restrictions in towns which border on one another give rise to all sorts of complications and unfairness. Of two towns, side by side, where one is conscientiously interested in the appearance of its streets and buildings and the other is not, the latter soon finds itself at a considerable disadvantage. Everything is to be gained by coöperation in planning. Waste is bound to ensue without it.

American Communities Coöperate

Newark, N. J., after four years of struggle with her plans came to realize so strongly the necessity of cooperative effort that she organized a "Conference of Interurban Improvement" and every week or so the city engineers or other representatives of some eighteen neighboring towns came together to discuss frankly their common problems. This "clearing house" has been of the greatest value. It has not only served to settle difficulties arising where towns touched one another, but has made it feasible to work out comprehensive plans for the development of the whole Newark metropolitan area. More than that, it has served to arouse from their lethargy the more backward towns and all have had an opportunity to become familiar with the best planning practice.

The Massachusetts Federation of Planning Boards in which the 56 planning commissions of the state have joined is serving as a splendid medium for education and has further great possibilities for effecting state-wide planning. The same is true of the Pennsylvania, California and Texas planning conferences and the City Planning Committee of the New York State Conferences of Mayors. They prove decidedly the value of coöperative endeavor.

Practice in Foreign Countries

London and Berlin have brought together the neighboring towns for comprehensive city planning. I saw recently in London comprehensive plans for the whole metropolitan area, some two thousand square miles. They have found that satisfactory planning can be done only where all the communities affected unite in the study of their common problems.

France is now passing a law which will make planning commissions compulsory not only in every city and town but will create one for every state (departments, as they are called there), and a general commission for the nation. They are doing this as a matter of "Preparedness for Peace."

The organization of the Westchester County Planning Commission is one of the most significant movements in this direction. It is the forerunner of the county or state commissions that are bound to be recognized throughout America in the near future as a necessity. It is most important as a medium for securing unity of thought and action in planning a region full of unorganized cities, towns and farming communities in the greatest variety. Without a general body such as this, planning within Westchester County would, at best, be chaotic. It is most fitting that the idea of city planning coöperation among all the communities within the New York metropolitan area should be initiated by the Westchester County Planning Commission.

ENGINEERING LITERATURE

A Review of Books and a Listing of New Publications

Inventory of Engineering Handbooks

From Haswell's Pioneer Work in 1844 to the Numerous Productions of 1916

By R. FLEMING

American Bridge Co., New York City

IF DR. ELIOT'S five-foot bookshelf were emptied, the space could be filled with engineering handbooks. The number of these books has increased rapidly the past few years, because the demand has increased. The writer proposes to take an inventory of handbooks he has seen during the past year, but will make no attempt to appraise the contents of any book.

"The Engineers' and Mechanics' Pocket-Book," a book of 264 pages, by Charles H. Haswell, "Chief Engineer U. S. Navy," was published in 1844. A "New Edition" was issued in 1846. The title of later editions reads "Mechanics' and Engineers' Pocketbook." The 76th edition, 150th thousand, a book of 1051 pages, bears the copyright date of 1912, but was printed, the publishers state, in 1915. Mr. Haswell revised his book many times and lived to see it pass through more than 70 editions. He was working at his desk upon material for a new edition, when, rising from his chair, he fell and sustained injuries from which he died the following day, May 12, 1907. Had he lived 10 days longer, he would have entered upon his 99th year.

Nystrom's "Pocket Book of Mechanics and Engineering," 265 pages, was published in 1854. A third edition was called for two years later. The 21st edition, 675 pages, was issued in 1895. The plates and stock were destroyed in a fire in 1899. Supplee's "Mechanical Engineer's Reference Book," fourth edition, 964 pages, 1913, is its successor.

The first editions of Haswell and Nystrom contain much of interest. From the "Dimension and Weight of Guns, Shot, and Shells, U. S. Army," in Haswell we learn that the heaviest gun in the United States Army at that time (10-in.) weighed 9500 lb. His title page states, "An examination of facts is the foundation of science." Nystrom begins his preface with, "Let every Engineer make his own Pocket-Book as he proceeds in study and practice, it will then suit his particular business." He devotes two pages to "Music" and three to "Ringing Bells."

In 1872, John C. Trautwine published "The Civil Engineer's Pocket-Book," 645 pages. This book at once met with a favorable reception. The "Tenth Thousand, Revised and Corrected" was sent out in 1876. The 19th edition, third issue, 120th thousand, 1272 pages, was published in 1913. This last issue has been translated and published in Spanish.

The "American Civil Engineers' Pocket Book," Mansfield Merriman, Editor in Chief, with a dozen Associate Editors, was published in 1911, and a third edition, 1600 pages, in 1916.

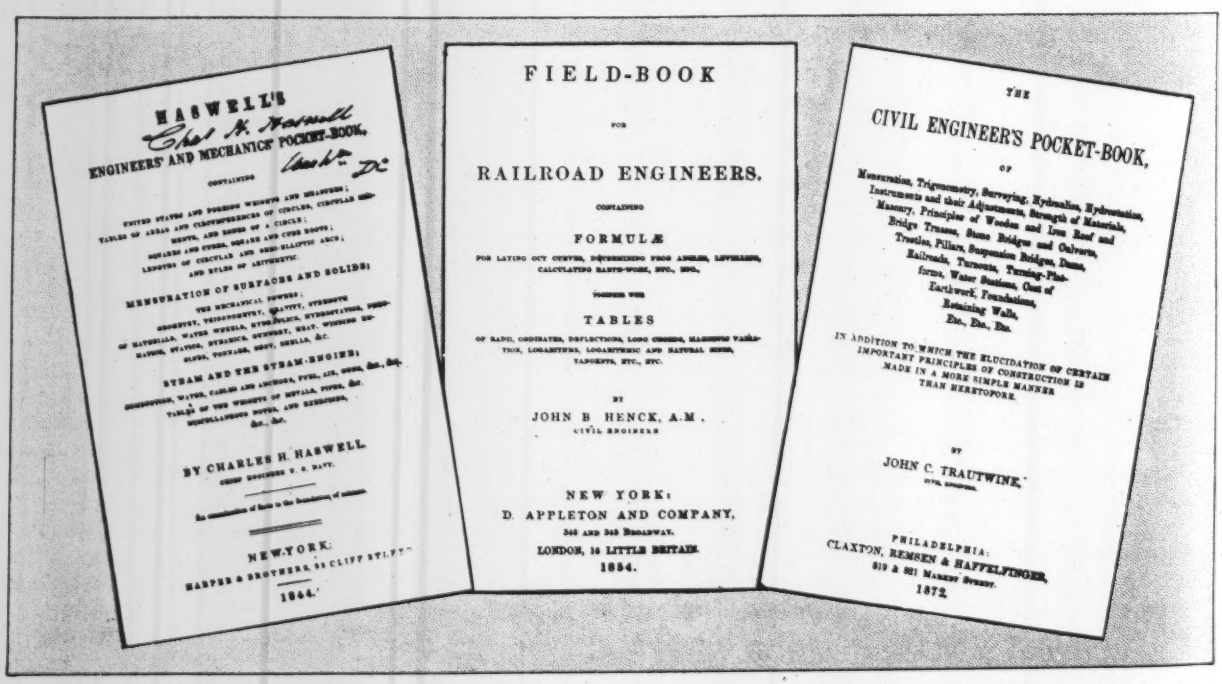


FIG. 1. TITLE PAGES OF ORIGINAL EDITIONS OF HASWELL, HENCK AND TRAUTWINE

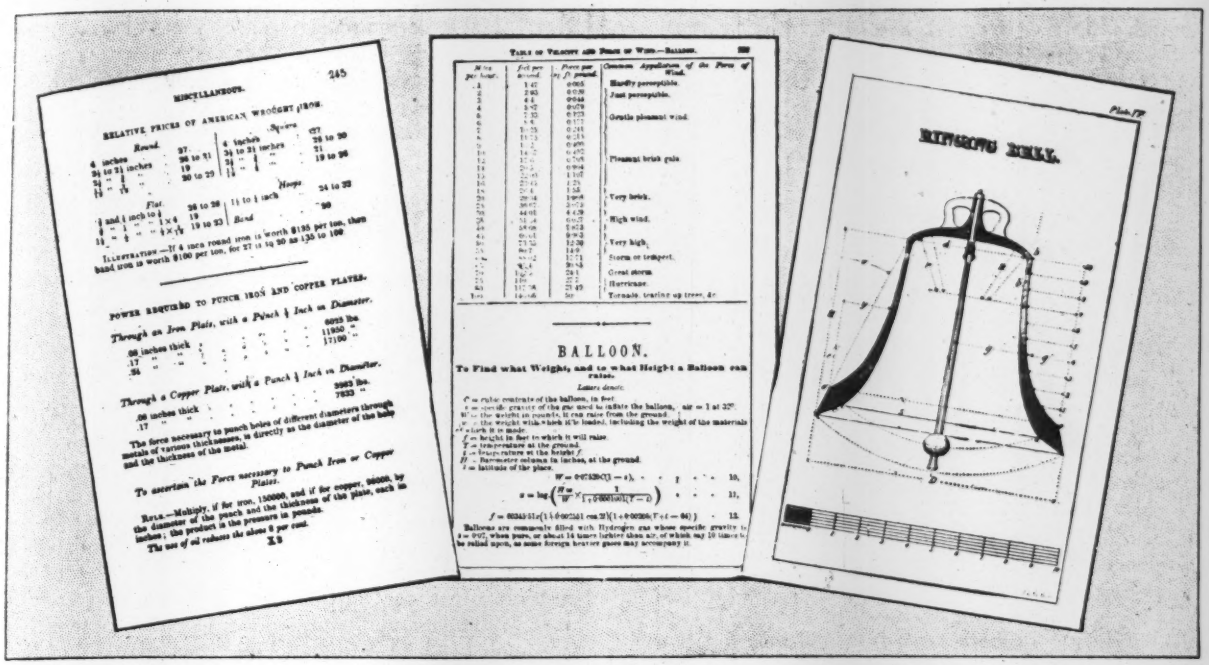


FIG. 2. REFERENCE PAGE FROM HASWELL AND TWO PAGES FROM NYSTROM ORIGINAL EDITIONS

Frye's "Civil Engineer's Pocket-Book," 1611 pages, bears the date 1913.

Ketchum's "Structural Engineer's Handbook," 896 pages, was brought out in 1914, and the eighth thousand printed in 1916.

The second edition of Harger and Bonney's "Highway Engineer's Handbook," 609 pages, bears the date 1916. Taylor's "Surveyor's Hand Book," 310 pages, 1908; "The Field Engineer," by Shunk, 324 pages, 1909; and Searle's "Field Engineering," 17th edition, 632 pages, 1915, may be mentioned here. Henck's "Field-book for Railroad Engineers," a book of 243 pages, was first issued in 1854. More than 16,000 copies of this edition were sold before it was revised in 1881. Additions and revisions were again made in 1896, bringing the number of pages to 312. The latest imprint (from the second revision) is dated 1912.

Kidder's well-known "Architect's and Builder's Pocket-Book" was first issued in 1884—a book of 576 pages. The 16th edition, 1816 pages, over three times the size of the first, was published in 1916.

Another well-known handbook is Kent's "Mechanical Engineer's Pocket Book." The first issue is dated 1895; the ninth edition, 1526 pages, total issue 108,000, is dated 1916.

The year 1916, so prolific in handbooks, marked the advent of "Mechanical Engineers' Handbook. Based on the Hütte and prepared by a staff of specialists. Lionel S. Marks, Editor-in-Chief." This is a volume of 1836 pages.

"Machinery's Handbook," 1400 pages, was published in January, 1914; 15,000 copies were sold, and a third edition of 6000 copies was brought out within less than three months after the first publication.

"American Machinists' Handbook," by Colvin and Stanley, second edition, 674 pages, is dated 1914. The total present issue is given as 76,000.

The size of pages in Halsey's "Handbook for Machine Designers, Shopmen and Draftsmen," second edition, 1916, is 8½ x 11 in., an unusual size.

"Waterworks Handbook," 824 pages, compiled by Flinn, Weston, and Bogert, is another of the handbooks brought out in 1916.

Dana's "Handbook of Construction Plant," 762 pages, 1914, begins with 22 pages on "Air Compressors" and closes with three pages on "Wheelbarrows." The compiler writes: "My justification for the alphabetical method of classification is that this scheme admits of more rapid service on my desk than any other."

Byrne's "Inspector's Pocket Book" has been before the public for 25 years. The third edition, 609 pages, is dated 1911.

The preface of "Tulley's Handbook on Engineering," sixth edition, 1072 pages, 1907, states: "Up to the date of the publication of this book, it was impossible to find a plain and practical treatise on the steam boiler, steam pump, steam engine, and dynamo, and how to care for them."

Swingle's "Handbook for Steam Engineers and Electricians," 1483 pages, has had a sale of over 100,000 copies. "The Modern Locomotive Engineering Handy-Book" is by the same compiler.

Electrical engineering is particularly rich in handbooks. Three noteworthy books are Foster's "Electrical Engineer's Pocketbook," seventh edition, 1599 pages, 1913; "Standard Handbook for Electrical Engineers," Frank F. Fowle, Editor-in-Chief, fourth edition, 1984 pages, 1915; and "American Handbook for Electrical Engineers," Harold Pender, Editor in Chief, 2023 pages, 1915. It is only 15 years since the electrical handbook of Foster, the pioneer in its line, was published.

Croft's "American Electricians' Handbook," 711 pages, 1913, is styled by the compiler "a reference book for practical electrical workers." Richey's "Electric Railway

Handbook," 832 pages, 1915, and the two handbooks compiled by the National Electric Light Association—"Electrical Meterman's Handbook," 1335 pages, 1915, and "Handbook on Overhead Line Construction," 819 pages, 1915—are devoted to their respective fields.

Roper's "Engineer's Handy-Book for Steam Engineers and Electricians," 15th edition, 844 pages, 1907, as well as some of Roper's series of "Practical Hand-Books for Engineers and Firemen" have been known for more than a generation.

The different pocketbooks issued by the International Correspondence Schools have been circulated in enormous numbers.

Heidenreich's "Pocketbook of Reinforced Concrete," 439 pages, 1915, and Marsh and Dunn's "Reinforced Concrete Manual," 312 pages, 1911, are two handbooks on an important subject. There needs to be written "The American Reference Book of Reinforced Concrete Construction." It should have the scope of "Trautwine" or "Kidder" or "Kent."

Siebel's "Compend of Mechanical Refrigeration and Engineering," ninth edition, 593 pages, 1915; Robert's "Gas-Engine Handbook," 315 pages, 1913; Gillette's "Handbook of Rock Excavation," 825 pages, 1916; "The Coal Miner's Pocketbook," 11th edition, 1172 pages, 1916; and Simpson's "The Naval Constructor," third edition, 819 pages, 1914, are recent issues on widely different subjects. Two others are Hoffman's "Handbook for Heating and Ventilating Engineers" and Hall's "Hand Book of Standard Telephone Construction Methods." Still another two are Macomber's "Engineers' Handbook on Patents" and Sypherd's "Handbook of English for Engineers."

It may be noted that one handbook has over 2000 pages, and several are nearly as large. However, "The Engineer's Year-Book of Formulæ, Rules, Data, & Memoranda For 1916," an English handbook compiled and edited by H. R. Kempe, is a book of 2303 pages, including the 336 pages of advertisements. The German "Taschenbuch für Bauingenieure," edited by Max Foerster, second edition, 1914, is a book of 2078 pages. The 22nd edition of the well-known "Hütte," brought out in 1915, is in three volumes of 1084, 1077 and 1109 pages respectively.

It may also be noted how successive editions of handbooks increase in size. An instance is Gillette's "Handbook of Cost Data," the first edition of which, 1905, had 610 pages, but the second, 1910, contained 1854 pages.

The foregoing list is not exhaustive. English and Scotch handbooks that might be added are Molesworth's "Pocket Book of Engineering Formulæ"; Hurst's "Architectural Surveyors' Hand Book"; O'Connor's "Gas Engineer's Pocket Book"; Haeder and Powle's "Handbook of the Steam Engine"; Traill's "Boilers"; McGibbon's "Marine Engineer's Pocket Book"; Mackrow's "Naval Architect's, Shipbuilder's, and Marine Engineer's Pocket Book"; Lock's "Miner's Pocket Book"; Fowler's "Mechanical Engineer's Pocket Book"; Low's "Pocket-book for Mechanical Engineers"; Fowler's "Electrical Engineer's Pocket Book"; Whittaker's "Electrical Engineer's Pocket Book"; Kempfe's "Handbook of Electrical Testing"; Lake's "Motor Cyclist's Handbook"; O'Gorman's "Motor Pocket Book"; and "The Field Engineer's Handbook," by Wells and Clay.

In conclusion, the suggestion is made that "Reference Book" is a more appropriate name than "Pocket Book" or "Handbook." Books of 1500 to 2000 pages are too large for the pocket, and books of a thousand 6 x 9 in. pages are more than *hand* books. All the books mentioned are reference books. Why not call them so?

REVIEWS AND NOTES

Cost Accounting and Reporting

Reviewed by R. R. Potter
Chief Engineer, Blood Brothers Machine Co., Allegan, Mich.

MANUFACTURING COSTS AND ACCOUNTS—By A. Hamilton Church. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. viii + 452; 139 illustrations. $5 net.

It is the purpose of this book to present the subject of costing in such a way as to bring together the points of view of cost men and of general accountants. In general, engineers are better acquainted with the details of cost finding than with the broader principles of cost keeping, which control the relationship of the cost man's work to the general accounts. Mr. Church's present book is intended to bridge this gulf and meet the need of those who, familiar with the details of the factory end of cost accounting, are ready to investigate the connection between costing records and the general books of account. Incidentally, engineers who have had to cope with the psychology of the accountant at first hand will appreciate Mr. Church's remark that "the peculiar value of detail to the technical arm has been emphasized with a view to exhibit to the general accountant a viewpoint that he sometimes misses."

The book is divided into three parts, the first of which gives a general outline of manufacturing accounts. The author describes briefly the books ordinarily used in a modern system of accounting and then discusses three methods for connecting the cost records on the books with the product of the factory—(1) by a lumped hourly cost including both labor and expense, (2) by charging expense as a percentage on direct labor hours, (3) the machine-rate method as developed by Mr. Church himself. Part II opens with a general diagram that, with proper study, makes clear the relationship of the cost records to the main books of account and explains means for unifying the general accounts and the cost system into a consistent whole. The separate features of manufacturing accounts, as outlined in Part I, are then taken up in greater detail. A number of explanatory diagrams are introduced as well as representative forms for cost records. Cost-system reports and returns for the foreman, superintendent and general executive are suggested and described in Part III. The four chapters making up this part are revised from a series of articles published in the *American Machinist* in September, 1915.

This volume differs from some others on the same subject in emphasizing the explanation of the "why and wherefore" of such points in accounting practice as are frequently not understood by engineers, and by many bookkeepers as well. It is sufficiently elementary in treatment to be recommended as a general textbook on accounting and cost keeping for the use of engineers needing instruction in those subjects.

American State Government

STATE GOVERNMENT IN THE UNITED STATES—By Arthur N. Holcombe, Assistant Professor of Government in Harvard University. New York: Macmillan Co. Cloth; 6 x 9 in.; pp. xiii + 498. $2.25.

PRINCIPLES OF AMERICAN STATE ADMINISTRATION—By John Mabry Mathews, Ph.D., Assistant Professor of Political Science in the University of Illinois. New York: D. Appleton & Co. Cloth; 6 x 9 in.; pp. xiii + 534. $2.50 net.

It is high time that serious attention should be given to state government in this country, since it is now so much poorer than municipal government in methods and results and so far behind our Federal Government in workable organization.

Each of the volumes listed above is a noteworthy production. Professor Holcombe covers the whole field of state government. Professor Mathews confines his study to administration, except in so far as legislation breaks into the administrative field. It is fortunate that the two books appeared at so nearly the same time, as Professor Holcombe's task was so great that even with more liberal space he could do no more than outline many phases of administration.

The larger book naturally goes farther than the smaller one into the fundamental principles and historical development of government in the United States. Each is based on sound principles of democracy and presents high ideals of efficiency as well. Each is amply supplied with biographical lists.

Professor Holcombe first considers the relations between the nation and several states. He then reviews the origin, development and detailed workings of the state governments. He concludes with a short discussion of further reform in state government, including propositions for the commission plan, a socialist scheme and two or three plans advocated in Oregon.

After discussing general principles, Professor Mathews takes up administrative organization, dealing at length with the governor, boards and commissions, the selection and removal of officials and the civil service. He then passes to administrative functions, including taxation and finance, education, health, law, justice and "newer functions." The latter are control of corporations and utilities, labor interests, agriculture and good roads, all of which important subjects together are given the inadequate space of 25 pages. Finally, needed administrative reforms are outlined.

Rapidly growing state activities touch the engineer, contractor and manufacturer at so many points that progressive men in each class would find it interesting and profitable to give careful reading and thought to each of these volumes. After doing both, they would be in a position to help on much needed reforms in the government of every state of the Union.

Pocket Book of Engineering Formulas

THE ENGINEERS' MANUAL—By Ralph G. Hudson, S.B., Assistant Professor of Electrical Engineering at the Massachusetts Institute of Technology and Harvard University; assisted by Joseph Lipka, Ph.D., of the Department of Mathematics; Howard B. Luther, S.B., Dipl. Ing., of the Department of Civil and Sanitary Engineering; and Dean Peabody, Jr., S.B., of the Department of Mechanical Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons. Flexible leather; 5 x 8 in.; pp. iv + 315; 971 illustrations. $2 net.

What is possibly the most concentrated type of engineering handbook is found in this volume. It is essentially a compilation of the formulas of engineering—civil, mechanical and electrical—together with outline mathematical operations and tables of constants. It covers the essentials of mechanics, properties of materials and structures (riveted joints, beams, structural-steel shapes, shafts, etc.), hydraulics, heat and power (including compressed air, refrigeration, steam and internal-combustion engines, heating and ventilation, etc.), electromagnetism, electric circuits and electrical machinery.

The book is designed to be really a pocket companion. Each formula is accompanied by a descriptive statement of application, symbols used and units of measurement. The sequence of the different parts of the book is progressive, so that the understanding of one page may be increased by study of the pages that precede it. Heavy-faced type spots the catchwords, symbols and formulas, so that use of the book is facilitated. The work appears well thought out and coördinated. It should have a field of service for both teaching and commercial practice.

Mainly for Roadmasters and Foremen

WINTER TRACK WORK—By E. R. Lewis, Assistant to General Manager, D. S. S. & A. R.R. Chicago (14 East Jackson Blvd.): Railway Educational Press, Inc. Cloth; 5 x 8 in.; pp. 157; 21 illustrations. $1.60.

The author has not stuck closely to his text. He treats incidentally of work in warm weather and hot climates, and also of the organization and equipment of track forces. Track shimming and snow clearing occupy a large share of the space given to winter work. Considerable attention is paid to the operation and care of motor section cars. A locomotive with 50 ft. of steam hose attached to a globe valve on the dome is suggested as a good outfit for clearing snow and ice from water tanks, switches, crossing flangeways, etc. A strong point in the book is its argument for permanent section forces and all-the-year-round trackwork, on the score of economy and efficiency. A weak point is its assumption that only the section forces know much about track or are competent to determine matters of policy and working methods. The book is written mainly for the roadmaster and section foreman.

Coöperative Education at Cincinnati

THE COÖPERATIVE SYSTEM OF EDUCATION—An account of Coöperative Education as Developed in the College of Engineering, University of Cincinnati—By Clyde William Park, Associate Professor of English, University of Cincinnati. Washington, D. C.: Bureau of Education, Bulletin, 1916, No. 37. Paper; 6x9 in.; pp. 48; illustrated. 20c. per copy from Superintendent of Documents.

A great deal has been written and spoken about the so-called "coöperative system of education" first put into effect in the Engineering Department of the University of Cincinnati ten years ago, but most of the magazine articles and public addresses relating to this departure deal with certain phases and special courses. No one has attempted to give as comprehensive and detailed a review of the system as has Professor Park in this bulletin of the United States Bureau of Education.

The origin and gradual development of the Cincinnati scheme, better called the Schneider scheme, are described at some length. The changes which were found necessary both in the shop employment of the student and the school instruction are explained, and the reasons given. The pamphlet shows a syllabus of the system and of a typical course (chemistry), thus giving in tabular and graphic form the relations between objects, method, matter and mechanism of instruction in the industrial shop and the college classroom.

One of the byproducts of the system described here is the scheme of determining in advance the fitness of the student for a particular type of work. It was found necessary to discard the examination of physical characteristics and the testing of psychological responses, and to fall back on the old-fashioned plan of trying the men on different jobs to see how they stood up under different kinds of work. They found that the boys could be variously tagged as settled or roving, directive or dependent, original or imitative, deliberate or impulsive, etc., and they have found what types of work require different combinations of these various qualities to secure the greatest promise of success.

The text is illustrated by photographs of work on which the students are engaged as regular employees at definite rates of pay. Appended to the booklet are typical instruction sheets issued to the coöperative students for helping them in their shop observations.

Bridge Stress Sheets and Details

Reviewed by A. W. Carpenter
Assistant Valuation Engineer, New York Central R.R. Co. (Buffalo and East), Grand Central Terminal, New York City

STEEL RAILWAY BRIDGES: Designs and Weights—By Edward C. Dilworth, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 12 x 10 in.; pp. viii + 185; 105 full-page plates. $4 net.

The 60 or more designs that form the principal feature of this book appear to the reviewer as fair examples of good practice, generally considered. They are conveniently presented in the form of stress sheets with general details (except riveting) and are good examples of the draftsman's art. Being designed especially for the book, according to the same well-known specifications throughout (American Railway Engineering Association, 1912) for the same loading and with a view to comparative uniformity in proportions and details, makes them a rather unique collection.

The designs reflect bridge-shop training rather than that of railroad or consulting bridge engineers' offices, and in that they of course bear strongly toward the practical. This tendency is shown in the use of adjustable web-counters in the pin-connected truss designs, the avoidance of metal over ¾-in. thick in angles and plates and some other features in which ease of shopwork is made the main consideration, also in the omission of such essential details as those for drainage and for closed connections with abutments in the solid-floor designs and the rather absurd attempts to show waterproofing construction in connection with some typical floor sections.

The adherence to the ¾-in.-thickness limit produces some flange sections with excess in cover plates, according to many authorities, and a doubtful sufficiency of thickness in gusset plates of double-track riveted trusses of 300-ft. span. A depth of 18 ft. for pony trusses with 12-in. wide verticals seems somewhat questionable. In omitting calculations for flange rivet pitch, some changes in a few of the designs would be necessitated to meet minimum pitch requirements, and in several cases the specifications are violated in minor requirements, such as those for use of stiffeners and minimum thickness of outstanding legs in compression.

The author makes a most peculiar misapplication of the specifications in proportioning girder webs for shear. The specifications plainly provide for these webs to be simply proportioned to the unit stress of 10,000 lb. per sq.in. on gross section of web, with further provision for stiffeners in case a certain ratio of depth to thickness of web is exceeded, in which case the stiffeners shall be spaced according to a given formula. The author derives from this stiffener-spacing formula a shearing-unit stress, using the term intended for the distance between stiffeners to apply to the assumed unsupported distance between flanges, and assuming a web thickness. The result is a varying value usually less than 10,000 lb. Most of the girder webs in the designs are proportioned to unit shears obtained in this manner, authority or reason for which is unknown to the reviewer.

An interesting general formula for weights is presented. The reviewer is of the opinion that it is too general and that separate formulas for girders, trusses, floors, bracing and shoes are more adaptable and useful. A comparison of the weights given by the author's curves and those by formulas which the reviewer prepared for spans designed on approximately similar specifications and which have been rather thoroughly proved in practice, shows the author's weights much the lower—more so than was to be expected from known differences in the conditions of design.

In the text portion of the book general considerations and reasons given by the author for choice of forms of construction are frequently not very satisfying, and a number of inconsistencies are noticed. In treating of details he does better. There is positive error in the theory of calculation presented for splices of girder web-plates for bending, in which the efficiency of the splice material depends properly upon the square of its distance from the neutral axis and not upon its direct distance, as shown—a not unusual error in practice. There are many other unsatisfactory presentations, minor errors in the figures of computations and in typography and some very crude expressions of formulas and statements. However, the text portion sets forth most of the usual rules and methods for proportioning and detailing, often very clearly and with complete examples of calculations, and it covers some features not generally found in other books. Stress calculations, except for details and certain special features, are not treated, but tables of moments, shears and draw-span reactions are given.

As a whole, the book presents, in its collection of practical designs, its extensive data on proportioning and detailing and other features, a valuable work for the instruction and reference of those who will not be misled by its rather numerous errors and inadequacies.

Water and Sewage Analysis Standards

STANDARD METHODS FOR THE EXAMINATION OF WATER AND SEWAGE—Revised by committees of the American Public Health Association, American Chemical Society and referees of the Association of Official Agricultural Chemists. Third edition. Boston (126 Massachusetts Ave.): American Public Health Association. Cloth; 7 x 10 in.; pp. xvi + 111. $1.25 postpaid.

The many chemists and bacteriologists who during more than a score of years have contributed by committee work and by coöperation with committees in compiling, expanding and perfecting standards for the examination of water and sewage are justly entitled to the thanks, not only of all sanitarians, but of all who enjoy the benefits of water and sewerage systems as well. The result of all this work to date is presented in the volume noted above, which is the second revision and third edi-

tion of the work done by the various committees that have dealt with the subject. In the present volume the technic of water and sewage analysis, chemical, microscopic and bacterial, is presented in workable detail, yet in small compass.

To the chemical section of the volumes there have been added in this edition methods for the examination of sewage sludge and muds, chemicals used in water treatment, and chlorine determination. Furthermore, there has been a regrouping of methods and a revision of diction. The bacterial section has been overhauled, and apparently a considerable amount of material not thought useful for the purposes of such a volume has been omitted. Useful bibliographies are included.

Labor Laws Reviewed and Forecast

PRINCIPLES OF LABOR LEGISLATION—By John R. Commons, LL.D., Professor of Political Economy, University of Wisconsin, and John B. Andrews, Ph.D., Secretary of the American Association for Labor Legislation. New York: Harper Brothers. Cloth; 5 x 8 in.; pp. 524. $2 net.

All who are following closely the relations between capital and labor will find this book a valuable manual. It presents clearly the form in which progressive handling of labor problems has been crystallized into law. The main topics of the volume are the basis of labor law, individual bargaining, collective bargaining, the minimum wage, hours of labor, unemployment, safety and health, social insurance, and administration of laws affecting labor.

From the book the reader will get not only clear ideas as to the history of the development and as to the present status of laws under each of these heads, but also, what is more important, a sense of the direction in which we are headed on every important phase of the relations between capital and labor which is, or is likely to be, covered by legislation.

For Marine-Engine Operators

PRACTICAL MARINE ENGINEERING: For Marine Engineers and Students; with Aids for Applicants for Marine Engineers' Licenses—Fourth edition, revised and enlarged by Captain C. W. Dyson, U. S. N., Bureau of Steam Engineering; author of "Screw Propellers and Estimation of Power for Propulsion of Ships." New York (461 Eighth Ave.): Marine Engineering. Cloth; 6 x 9 in.; pp. xvi + 982; 550 illustrations. $6.

The first edition of this book was written by Prof. W. F. Durand "for the operative or practical marine engineer" and was favorably reviewed in *Engineering News* of Mar. 20, 1901, p. 234. A second and then a third part were subsequently added. In the present edition Captain Dyson has combined the three independent parts into a consecutive whole, besides adding new material. The book is devoted mostly to marine engines and their many auxiliaries for driving ships and making them habitable. There are also chapters on engineering materials, fuels and computations for engineers.

Thirteen Great Engineers

THE JOHN FRITZ MEDAL, with Biographical Notices of the John Fritz Medallists—Compiled or condensed from various sources and edited by Rossiter W. Raymond, Ph.D., LL.D., Secretary Emeritus of the Am. Inst. M. E. New York: The John Fritz Medal Board of Award. Boards; 6 x 9 in.; pp. 98; illustrated. $4.

The engineering profession ought to know and appreciate its great men. This book is a contribution toward that result. It contains the portraits and brief biographies of the 13 eminent engineers upon whom the John Fritz medal has been conferred. As many will recall, the John Fritz medal was founded on the eighteenth birthday of John Fritz, Aug. 21, 1902, to perpetuate the memory of his achievements in industrial progress. It has been awarded annually since by a board made up of four representatives from each of the four national engineering societies and is given "for notable scientific or industrial achievement."

The biographies have been prepared by Dr. Rossiter W. Raymond, to whom the profession owes a debt for the ability with which he has told the life story of many of its distinguished men.

The 13 men who have received the medal include, among those who have passed away, John Fritz himself, Lord Kelvin, George Westinghouse, Charles [illegible] Porter, Alfred Noble, Sir William White and John E. Sweet. Those who are still living are Alexander Graham Bell, Thomas A. Edison, Robert W. Hunt, James Douglas, Elihu Thomson and Henry M. Howe.

All About City Milk Supply

CITY MILK SUPPLY—By Horatio Newton Parker, Member, International Association of Dairy and Milk Inspectors. New York: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. xi + 493; 63 illustrations. $5.

Such a thoroughly up-to-date book on milk supply as this, written by a man who has dealt with the subject as inspector, health officer, analyst and teacher, should certainly make a broad and telling appeal to all who are concerned with public health and sanitation.

The volume opens with a discussion of milk and of the diseases which it may convey. The dairy cow and farm are next considered from various angles. Then come valuable chapters on the sanitary production of milk and on milk transportation. The importance of the milk contractor is duly recognized by a chapter of 142 pages. Nearly as much space is given to an able review of methods of public control of milk supplies, this subject having been wisely reserved to the last. Each chapter is supplied with a source reference list.

The book deals adequately with its subject and might well serve as a model for writers who have not yet learned the knack of selecting the most essential facts from a vast amount of material and presenting them in concise, orderly, instructive and readable form.

Reinhardt's "Lettering" Revised

LETTERING FOR DRAFTSMEN, ENGINEERS AND STUDENTS: A Practical System of Freehand Lettering for Working Drawings—By Charles W. Reinhardt, Former Chief Draftsman, "Engineering News." Fourteenth edition, revised and enlarged. New York: D. Van Nostrand Co. Boards; 8 x 11 in.; pp. 39; 15 plates. $1 net.

More than 20 years of use under all sorts of conditions have proved the value of Reinhardt's "Lettering." This is well attested by the fact that the book has reached its forty-fifth thousand.

In the preface to the first edition the author stated that, while there were then many books that dealt with ornamental lettering, there was none which treated the art "from a purely practical viewpoint." To make good so great a lack, he set forth simply and clearly a very practical method of producing most effective results in the freehand lettering of working drawings.

Previous editions are too well known by engineers and draftsmen to need description. The present edition has been given "a more rounded aspect," to quote from the

preface, by supplying such apparent omissions as an analysis of the Greek alphabet, methods of laying out and constructing titles and by adding some practice sheets.

Industrial Administration Outlined

ADMINISTRATION OF INDUSTRIAL ENTERPRISES—By Edward D. Jones, Ph.D., Professor of Economics and Industry, University of Michigan. New York: Longmans, Green & Co. Cloth; 5 x 8 in.; pp. 442. $2 net.

Although the preface does not indicate it, this volume is better suited for use as a textbook than as a guide to executives of industrial plants. It covers too wide a range to touch more than lightly on the vital things that make for successful management. The man with executive problems to solve will need fuller treatment.

The book covers industrial administration in every phase—financing, plant location and layout, buildings, power, functions of works manager, accounting, employment, wage systems, welfare work, purchasing, selling, advertising, traffic, credits and collections.

Bridge Specifications in Spanish

By a skillful and patient piece of translating, C. T. Brady, engineer in Buenos Aires of the United States Steel Products Co., has done a service to engineers of both Argentina and the United States. It is well to remember that the American Railway Engineering Association bridge specification, which he translated, is perhaps the most nearly standard of all our bridge specifications. This translation supplements those of the American Society for Testing Materials specifications, made by one of the United States Government bureaus last year for aiding trade with South America; it also helps to rectify the error of the Government in translating the specifications of one society only. Mr. Brady advises us that he had the assistance of several prominent Argentine engineers in making the translation and the work received careful revision by the inspector general of structures of the Government railway department. This is fortunate in view of the difficulties arising in translating specific technical terms. The work may thus help to lay the foundation for a better correspondence of ideas in the bridge field, between the two countries and their languages. The translation, accompanied by notes on American bridge and bridge-shop practice, fills 18 pages of "Boletin de Obras Publicas de la Republica Argentina," July-December, 1916 (Buenos Aires, Argentina: Ministerio de Obras Publicas).

Technical-Literature Searches

It is not as widely known as it should be that for 15 years past the American Society of Civil Engineers has made library searches of technical literature on request. It has recently reprinted from its "Transactions" (Vol. LXXX, pp. 2086-2108, 1916) a "Classified List of Searches Made in the Library, January, 1901, to November, 1916." For each search there is given its subject, year made, number of references, cost and search number. Avoiding extremes, the cost of the searches runs from, say, 50c. to $10. Copies may be obtained at 50% the original cost, by nonmembers as well as members of the society. Application should be made to the Librarian of the United Engineering Societies, with which that of the American Society of Civil Engineers has been consolidated.

Testing Bituminous Paving Materials

Opinions and processes of a commercial testing laboratory, mainly in reference to the testing of bituminous materials, are stated in Bulletin 12 of the Kansas City Testing Laboratory, under the title "Asphalt Pavement —Specifications and Properties" (Kansas City, Mo.; 50c.). The bulletin defines various types of mixtures, gives an epitome of the purposes of certain specifications for asphaltic cement and offers an explanation of the relation of the defects of an asphalt pavement to its physical properties, calling attention to the fact that many failures of asphalt pavement can be traced to the poor quality of the concrete base.

Aid to Better Technical Writing

To promote better work in the field indicated by the title, "A Bibliography of Scientific and Technical Writing" has been compiled by W. R. Raymond, J. H. Atkinson and A. Starbuck, of the English Department, Iowa State College of Agriculture and Mechanic Arts (Ames, Iowa), in coöperation with instructors in a number of other technical schools. Most of the references in the list, filling five pages, are to books, but some are to various articles and bulletins. Such of the efforts listed as have been examined and approved as to style are distinguished by asterisks, but not all the material has been examined.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

THE ACTIVATED SLUDGE PROCESS OF SEWAGE PURIFICATION—By Edward Ardern, M. Sc. [Read before Manchester Section, Dec. 1, 1916; reprinted from the "Journal" of the Society of Chemical Industry, Jan. 31, 1917. No. 2, Vol. XXXVI.] London (Broadway Chambers, Westminster, S. W.): Offices of the Society. Paper; 8 x 11 in.; pp. 6.

AMERICAN ASSOCIATION OF PORT AUTHORITIES: Proceedings and Papers of Annual Convention Held at Montreal, Can., Sept. 13-15, 1916—New York: The Secretary. Paper; 6 x 9 in.; pp. 272.

ANALYSES OF COALS PURCHASED BY THE GOVERNMENT, 1908-1915—By George S. Pope. Bulletin 119. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 118. 15c. from Superintendent of Documents.

ANNUAL REPORT OF THE HIGHWAYS DIVISION OF THE DEPARTMENT OF PUBLIC WORKS AND MINES AND OF THE SUBSIDIZED RAILWAYS, PROVINCE OF NOVA SCOTIA, for the Year Ended Sept. 30, 1916—By Hiram Donkin, C. E., Road Commissioner and Provincial Engineer. Halifax, N. S.: Commissioner of Public Works and Mines. Paper; 7 x 10 in.; pp. 111; illustrated.

THE APPLICATION OF HYPERBOLIC FUNCTIONS TO ELECTRICAL ENGINEERING PROBLEMS—By A. E. Kennelly, M.A., D.Sc., Professor of Electrical Engineering at Harvard University. New York: McGraw-Hill Book Co. London: University of London Press. Cloth; 5 x 8 in.; pp. xi + 302; 88 illustrations. $2.50 net.

THE BASIS ON WHICH MUNICIPALITIES SHOULD ASSESS THE COST OF FIRE PROTECTION—By W. C. Hawley. [Paper read at Annual Meeting of Pennsylvania Water-Works Association, Atlantic City, N. J., Oct. 19, 1916.] Wilkinsburg, Penn. (Pennsylvania Water Co.): The Author. Paper; 6 x 9 in.; pp. 6.

BIENNIAL REPORT OF THE BOARD OF STATE HARBOR COMMISSIONERS FOR THE HARBOR OF SAN FRANCISCO, July 1, 1914, to June 30, 1916—San Francisco, Calif. Paper; 6 x 9 in.; pp. 110; illustrated.

BUTT TREATMENT OF WOODEN POLES—By A. B. Campbell. Technical Service Bulletin 28, Engineering Extension Department. Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Paper; 6 x 9 in.; pp. 19; illustrated.

CANADIAN DEPARTMENT OF RAILWAYS AND CANALS: Annual Report, Apr. 1, 1915, to Mar. 31, 1916—Ottawa: Minister of Railways and Canals. Paper; 6 x 9 in.; pp. 445; illustrated. Maps in folder. 50c.

CHEMISTRY OF MATERIALS OF THE MACHINE AND BUILDING INDUSTRIES—By Robert B. Leighou, Sc.B., Associate Professor of Chemistry in the Carnegie Institute of Technology. New York: McGraw-Hill Book Co. Cloth; 5 x 8 in.; pp. xv + 449; 75 illustrations. $3 net.

COLORIMETRIC TEST FOR ORGANIC IMPURITIES IN SANDS—By Duff A. Abrams, Professor in Charge of Laboratory, and Oscar E. Harder, Chemist. Circular No. 1, Structural Materials Research Laboratory. Coöperation of Portland Cement Association and Lewis Institute. Chicago: Lewis Institute. Paper; 6 x 9 in.; pp. 7.

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES—By Henry Kreisinger, F. K. Ovitz and C. E. Augustine. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 76; 21 illustrations. 15c. from Superintendent of Documents.

A COMPARISON OF THE ACTIVATED SLUDGE AND THE IMHOFF TANK TRICKLING FILTER PROCESSES OF SEWAGE TREATMENT—By Harrison P. Eddy. [Reprinted from the "Journal" of the Western Society of Engineers, December, 1916.] Boston, Mass. (14 Beacon St.): The Author. Paper; 6 x 9 in.; pp. 37; 11 illustrations.

CONTRACTS, SPECIFICATIONS AND ENGINEERING RELATIONS—By Daniel W. Mead, Consulting Engineer, Professor of Hydraulic and Sanitary Engineering, University of Wisconsin. New York: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 535; illustrated. $3 net.

THE EFFICIENT PURCHASE AND UTILIZATION OF MINE SUPPLIES—By Hubert N. Stronck, E.M., M. Am. Inst. Min. E., and John R. Billyard, E.M., Mining Engineer. New York: John Wiley & Sons. Cloth; 5 x 8 in.; pp. 97; 24 illustrations. $1.25 net.

ELECTRIC AND MAGNETIC MEASUREMENTS—By Charles Marquis Smith, Associate Professor of Physics, Purdue University. New York: Macmillan Co. Cloth; 5 x 8 in.; pp. 373; 171 illustrations. $2.40.

FIFTEENTH ANNUAL REPORT OF THE UNITED STATES RECLAMATION SERVICE, 1915-16—Washington, D. C.: Department of the Interior. Paper; 6x 9 in.; pp. 808. 60c.

A HANDBOOK OF BRIQUETTING—By G. Franke, Professor of Mining, Ore Dressing and Briquetting in the Kgl. Bergakademie, Berlin. Translated by Fred C. A. H. Lantsberry, M.Sc., Head of the Birmingham Small Arms Co.'s Laboratory. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. In two volumes. Vol. I. The Briquetting of Coals, Brown Coals and Other Fuels. Cloth; 6 x 9 in.; pp. xxviii + 631; 255 illustrations. $9.

THE HEALTHFUL HOUSE—By Lionel Robertson and T. C. O'Donnell. Battle Creek, Mich.: Good Health Publishing Co. Cloth; 6 x 10 in.; pp. 191; illustrated. $2.

A sketchy, padded but handsomely made and generally sane book designed to emphasize "the health importance" of the æsthetic equally with the hygienic features of the house including its site, furniture and other equipment. Some of the remarks on house sanitation are of the old bogey type—such as that wall-paper paste is a good culture medium for disease germs (p. 37).

THE JOURNAL OF THE IRON AND STEEL INSTITUTE. Vol. XCIV—Edited by George C. Lloyd, Secretary. London (28 Victoria St., S. W.): Offices of the Institute. New York: Spon & Chamberlain. Cloth; 6 x 9 in.; pp. 503; illustrated.

MANUFACTURE AND PROPERTIES OF SAND-LIME BRICK—By Warren E. Emley, Associate Chemist. Technologic Paper No. 85. Washington, D. C.: United States Bureau of Standards. Paper; 7 x 10 in.; pp. 41; illustrated. 10c. from the Superintendent of Documents.

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK: Proceedings for 1915—Edited by Percy C. Barney, Chairman, Publication and Library Committee. New York: The Municipal Engineers. Cloth; 6 x 9 in.; pp. 494; illustrated.

THE OWNERSHIP OF WATER-SERVICE PIPES—By John W. Alvord, Consulting Engineer. [Paper read at the second annual convention of the New Jersey Utilities Association, Atlantic City, N. J., Oct. 13 and 14, 1916.] Chicago, Ill.: The Author. Paper; 6 x 9 in.; pp. 11.

PAVING ECONOMY: ROAD AND STREET—By Charles A. Mullen, Director of Paving Department, Milton Hersey Co., Industrial Chemists, Inspectors, Consulting Engineers, Montreal, New York, Winnipeg, Montreal, Canada: Industrial and Educational Press. Paper; 6 x 9 in.; pp. 98. $1.

THE PERSONAL RELATION IN INDUSTRY—By John D. Rockefeller, Jr. New York (26 Broadway): The Author. Paper; 5 x 7 in.; pp. 43.

PRELIMINARY MATHEMATICS—By F. E. Austin, Author of "How To Make Low-Pressure Transformers," etc. Hanover, N. H. (Box 441): The Author. Cloth; 5 x 8 in.; pp. 169. $1.20.

PUBLIC-UTILITY RATES: A Discussion of the Principles and Practice Underlying Charges for Water, Gas, Electricity, Communication and Transportation Services—By Harry Barker, B.S., M. Am. Inst. E. E., Mechanical and Electrical Engineer; Associate Editor of "Engineering News-Record." New York: McGraw-Hill Book Co. London: Hill Publishing Co. Cloth; 6 x 9 in.; pp. xiv + 387. $4 net.

REINFORCED-CONCRETE DESIGN TABLES: A Handbook for Engineers and Architects for Use in Designing Reinforced-Concrete Structures—By M. Edgar Thomas and Charles E. Nichols. New York: McGraw-Hill Book Co. Flexible leather; 4 x 7 in.; pp. 208. $3 net.

REPORT OF MICHIGAN STATE HIGHWAY COMMISSIONER, for Two Fiscal Years Ended June 30, 1916—Lansing, Mich.: State Highway Commission. Paper; 6 x 9 in.; pp. 140; illustrated.

REPORT OF THE STATE GEOLOGIST ON THE MINERAL INDUSTRIES AND GEOLOGY OF VERMONT, 1915-16—Burlington, Vt.: George H. Perkins, State Geologist and Professor of Geology, University of Vermont. Cloth; 6 x 9 in.; pp. 333; illustrated.

REPORT OF THE STATE WATER COMMISSION OF CALIFORNIA, from Mar. 1, 1915, to Dec. 1, 1916—San Francisco, Calif.: Josephine A. Patten, Secretary. Paper; 6 x 9 in.; pp. 183; illustrated.

Contains Water Commission act and sections on state riparian rights, water rights, uses of water, irrigation districts, private irrigation enterprises, groundwater, duty of water for rice culture, check dams and spreading water on débris cones. At the present rate of increase, rice production will soon equal wheat production in California.

THE SANITARY DRINKING FOUNTAIN—By J. H. Dunlap, Assistant Professor of Hydraulics and Sanitary Engineering, State University of Iowa, Iowa City, Iowa. [Reprinted from the "Journal" of the American Water-Works Association, March, 1917.] Paper; 6 x 9 in.; pp. 5.

A SANITARY SURVEY OF THE BOROUGH OF GLEN RIDGE, NEW JERSEY—By Murray P. Horowitz, M.S., Department of Biology and Public Health, Massachusetts Institute of Technology. Trenton, N. J.: Department of Health of the State of New Jersey. Paper; 6 x 9 in.; pp. 43; illustrated.

SOME MODERN METHODS OF VENTILATION, with Special Reference to Public Buildings, Standards of Ventilation, Design of Ducts, Selection of Fans, Washers and Heaters, Specifications, Test Forms and Specimen Schedules for Designers—By R. Grierson, Assoc. M. Inst. M. E., Assoc. M. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 187; 37 illustrations. $3 net.

SOME VITAL FACTS AND CONSIDERATIONS IN RESPECT TO COMPULSORY HEALTH INSURANCE: Substantially as Presented at Legislative Hearings in New York State and in Massachusetts on Mar. 7 and Mar. 13, 1917, respectively—By Magnus W. Alexander. West Lynn, Mass.: The Author. Paper; 6 x 9 in.; pp. 15.

STEAM TURBINES: A Textbook for Engineering Students—By William J. Goudie, B.Sc., M. Inst. Mech. E., Reader in "Theory and Practice of Heat Engines," University of London. London and New York: Longmans, Green & Co. Cloth; 6 x 9 in.; pp. x + 519; 230 illustrations and numerous examples. $4 net.

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The natural factors of wood which influence the growth and destructive properties of wood-destroying fungi are considered. The scholarship mentioned is maintained by the Southern Pine Association.

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THEORY AND CALCULATION OF ELECTRIC CIRCUITS—By Charles Proteus Steinmetz, A.M., Ph.D. New York: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 361; 133 illustrations. $3 net.

THE TRACTIVE RESISTANCE ON CURVES OF A 28-TON ELECTRIC CAR—By Edward C. Schmidt and Harold H. Dunn. Urbana, Ill.: University of Illinois. Bulletin 92, Engineering Experiment Station. Paper; 6 x 9 in.; pp. 54; illustrated. 25c.

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THE VAPORIZING OF PARAFFIN FOR HIGH-SPEED MOTORS (Electric Ignition Type)—By Eward Butler, M. Inst. M. E. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. Cloth; 5 x 8 in.; pp. 120; 88 illustrations. $1.25.

WESTERN AUSTRALIA WATER-SUPPLY, SEWERAGE AND DRAINAGE DEPARTMENT: Annual Report, 1915-16—Perth, Western Australia. Paper; 8 x 13 in.; pp. 78.

WHARVES AND PIERS: Their Design, Construction and Equipment—By Carleton Greene, A.B., C.E., M. Am. Soc. C. E. New York: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 248; 155 illustrations. $3 net.

WIRING FOR LIGHT AND POWER—A Detailed and Fully Illustrated Commentary on the More Important Portions of the National Electrical Code. By Terrell Croft, Consulting Electrical Engineer; author of "American Electricians' Handbook," "Wiring of Finished Buildings," etc. New York: McGraw-Hill Book Co. Leather; 5 x 8 in.; pp. xii + 426; 382 illustrations. $2 net.

WORKMEN'S COMPENSATION LAWS OF THE UNITED STATES AND FOREIGN COUNTRIES—Bulletin No. 203. Washington, D. C.: United States Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 961.

THE ENGINEER IN FIELD AND OFFICE

A Department Devoted to Details of the Day's Work

Buzz Saw Cuts Ice

A BUZZ SAW mounted on a sled and driven by an engine was used in ice harvesting this last winter by the Western Grain and Coal Co., of Winona, Minn. This company has the largest ice storage in the locality and adopted the machine to keep horses off the lake. It replaces four plowing teams. Seven traverses of a plow were required for a 12-in. cut, while the saw makes a kerf 16 in. deep. The ice, which was 28 in. thick, was

BUZZ SAW REPLACED FOUR TEAMS

cut in 8 x 16-ft. rafts and floated to the elevator, where men split it into 22 x 32-in. cakes.

The saw was 36 in. in diameter, and its shaft was mounted on a pivoted lowering frame. The saw shaft was belt driven by a 28-hp. four-cylinder gasoline engine.

How Preserve Section Corners in Permanently Paved Roads?

By NATHAN C. ROCKWOOD
Brooklyn, N. Y.; Formerly Associate Editor, "Engineering News"

A point little discussed in the hard surfacing of roads in the states from Ohio west, which are sectioned and quarter-sectioned by public land surveys, and where the highways often follow the section lines, is the treatment of the corner monuments within the paved way. Whose business is it to see that the monuments are properly preserved? Shall they be left under the pavement and referenced, or be set in the pavement, or shall suitable marks in the pavement surface show their location under it? Is there any uniform practice in this matter?

Inquiries addressed to several state highway departments bring the information that the problem is in quite unsettled condition. Answering the last question first, there is no uniform practice in the different states, or even within the same state by the several road-building authorities.

The State Highway Department of California, which has paved many hundred miles of country road with concrete, has no uniform policy. The practice, according to Austin B. Fletcher, state highway engineer, is merely "to preserve the monuments as carefully as possible and to have their locations where they may be covered up shown on the permanent plans of the state highways."

In Utah the surveyor general of the state has agreed that wherever land corners are encountered it would be satisfactory if the corners were lowered below grade and were witnessed along the right-of-way, but off the road. This has been done in one instance, and the state road engineer, E. R. Morgan, considers the method practicable and inexpensive, but he does not recall whether the witnessing was done by the state highway department engineers or by a deputy (U. S.) surveyor, or whether in the first case the act was approved by the deputy surveyor or not.

Monuments Set in Minnesota and Wisconsin

The State Highway Department of Minnesota has no special monument, but in several of the counties concrete monuments 30 in. long, 5 in. in diameter at the top and 10 in. in diameter at the bottom, with an iron center rod or pin, are set with the top of the monument at the surfaced grade. (George W. Cooley, is state engineer.)

The only part of Wisconsin where this problem is handled in a systematic way, according to A. R. Hirst, state highway engineer, is in Milwaukee County, where steel markers are used. These are iron bolts about 1 in. in diameter, about 2 ft. long, pointed at one end, with a head approximately 2 in. in diameter at the other end. The exact center of the head is indicated by the intersection of two lines at right angles. Wherever the construction work approaches an old section corner or other land monument, the latter is carefully referenced, then removed, and after the subgrade is finished the iron bolt is driven into the ground in true position. The top of the bolt is flush with the finished surface of the pavement. The bolt is concreted in and remains always accessible, its head being exposed in the surface of the pavement.

Placing the monument at the surface of the pavement is practicable, because all of the pavements laid in this county are either concrete or asphalt, a large proportion being concrete. In case macadam or other lower class pavements were used, the state highway engineer states, it is likely that it would be better to place the monument flush with the top of the subgrade.

Illinois and Iowa Merely Witness the Monuments

The new specifications of the Illinois State Highway Department, we are informed by W. W. Marr, chief state highway engineer, will provide that all public land survey monuments shall be cared for under the direction of the county surveyor (who by the law of this state is the only official having jurisdiction over them) at the contractor's expense, the cost of such work to be included in the price bid by the contractor. The state highway department has no standard monument, and such monuments as have been encountered have been left undisturbed where prac-

ticable. Otherwise they have been buried under the paved area and carefully witnessed and referenced.

The present road law of Iowa provides:

> Whenever it may become necessary in grading the highways to make a cut which will disturb or destroy or a fill that will cover up a government or other established corner, it shall be the duty of the engineer to establish permanent witness corners, and make a record of the same, which shows the distance and direction the witness corner is from the corner disturbed or covered up. A failure to perform this duty shall subject the engineer to a fine of not less than $10 nor more than $50, to be collected on his bond.

In conformance with this requirement of the law, according to F. R. White, road engineer, the Iowa county engineers, in making surveys for reducing the road to permanent grades, establish witness corners far enough away from the center of the road so that they will not be interfered with by the cuts and fills, and a record is made of these witness corners in the county recorder's office. Occasionally, temporary witness corners are established and the permanent section corner is removed temporarily to permit of the road construction work, after which the section corner is replaced and a record of the same filed in the county recorder's office. Iowa has no hard paved country roads.

Gas Pipe Is Used in Wayne County

In Michigan it has been the practice, more especially in Wayne County, where the largest mileage of concrete roads has been laid, to replace the section and quarter-section monuments with pieces of gas pipe, which extend up through the concrete pavement and are about flush with its surface. In the case of gravel-road construction, general in most of the country districts of this state, gas pipe is also used quite commonly, but the top of the pipe is kept under the metal bed of the road. (Frank F. Rogers, state highway commissioner.)

The county highway superintendent of each county in Ohio is by law the local representative or resident engineer of the State Highway Department. According to Clinton Cowen, state highway commissioner, he is the one who looks after witnessing the locations or replacing any monuments that may fall within the line of the state highway improvements. There is no special type of monument. Of course, as the official representative of the county, his work is made a matter of public record so that a corner or monument covered up may be found by such witness or reference marks as he selects and reports.

Cast-Iron Block Is Used as Mark in Vermilion County

In conclusion, the practice of P. C. McArdle, superintending engineer of the bond issue roads of Vermilion County, Illinois, seems to be about the best that has come to light. His practice is to reference a corner before grading commences and if the corner stone is above grade, it is lowered below the top of the subgrade and a mark placed directly in the concrete or brick paving slab, flush with the surface. These marks are made of cast-iron blocks 3 x 3 x 6 in. and weigh about 15 lb. One end of this block has an indented star. The center of this star is the section or quarter-section corner. These marks are furnished by the county and placed by the contractor under the direction of the resident engineer as a part of the regular work.

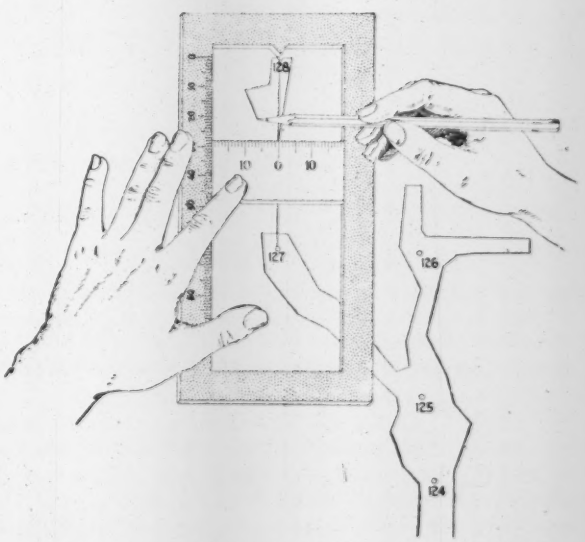
When To Use Trestles in Making Railroad Embankments

WHEN to use trestles in making railroad embankments and when to raise the track as the fill progresses are questions not to be settled by any general rule, according to the report of the roadway committee at the recent convention of the American Railway Engineering Association. Some engineers, the committee states, consider it almost always preferable to use a trestle, while others would raise the tracks up to 25 ft. or more.

In treating each individual problem the cost of raising the tracks, it is pointed out, should be carefully figured, including the delays and interference caused to and by traffic (if this exists), and this total should be set against the cost of trestling, including labor and materials. In some cases a run-around to carry traffic clear of the work can be made very cheaply, while in others this requires an auxiliary fill or trestle. In estimating for trestles that are not to carry regular traffic, the length of haul is important, because where this is less than two miles light side-dump cars may be used and a very light trestle will suffice. Geographical location has an important influence, as climate, character and availability of materials, labor, lumber and other supplies vary enormously in different sections of the country.

Offsets Easily Plotted with Frame and Sliding Piece

A DEVICE for mapping survey notes, consisting of a fixed frame for longitudinal measurements and a sliding scale for offset distances, is shown in the accompanying sketch. The rectangular frame is made of ¼-in. sheet iron. The scale along the left-hand edge can be stamped on or glued on. The sliding scale can be readily made from an old celluloid triangle. To orient the scales, the center point at the top of the hollow rectangle, which is opposite the zero of the longitudinal scale, is set over one transit point and the zero of the sliding scale over the other. The edge of the sliding scale will then always be at right angles to the base line.



PLUSES AND OFFSETS EASILY PLOTTED BY THIS DEVICE

This device was described by William G. Zulch, of Independence, Colo., in a recent issue of the *Engineering and Mining Journal*. The application there pointed out was the rapid mapping of such irregular lines as the sides of mine drifts. It is plainly seen, however, that any survey made by pluses and right-angle offsets from a base line, such as railroad station-map surveys, can be as readily plotted with the device. While it was not suggested by Mr. Zulch, it might be convenient to provide four scales by starting one from each of the four corners of the steel frame, and making two sliding pieces with a scale on each face. Both a 50-ft. and a 100-ft. scale would be used frequently.

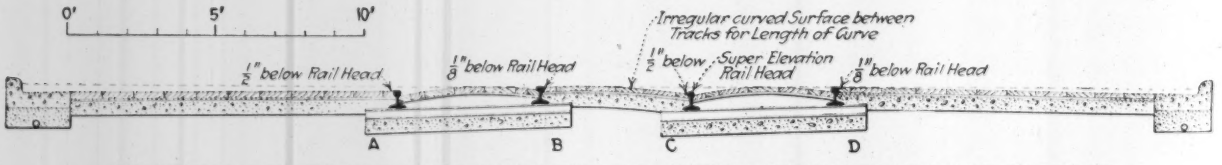
Pavement Along Rails Should Be Lowered

By E. W. WENDELL
Assistant Engineer, New York State Highway Department, Albany

ALL pavements, within the line of possible contact, should be laid below the plane of the tread of a car wheel. Consider the case of a T-rail such as is shown in the illustration—though it should be borne in mind that the above rule holds for any other type of rail. The rail head is 2½ in. wide, while the wheel tread is 3 in., measured from the gage line. Hence, even without any wear in the tread, if the pavement is flush with the rail top the tread will ride in contact with the paving surface for the width of the overhang. But the rail head wears, and not infrequently the tread grooves, so that the overhang is below the head on tangent track. While perhaps the railway company should be prohibited from using such equipment, it must be recognized that such cars are owned and operated; and as long as an adverse condition exists, engineers should meet it with proper design.

The speed of cars being generally regulated by law to a certain safe maximum, there is no necessity for elevating the outer rail on curves to an amount that will distort the cross-section of the street and spoil the section. The illustration shows a 2-in. elevation, but this is more than will be found in practice except in very unusual cases. This section shows clearly the details and dimensions used to overcome the destructive effect of the overhanging tread, but even on tangents at least a ⅛-in. difference in grade should be maintained between the rail head and the pavement surface directly adjacent to it. On curves the amount of superelevation must first be decided upon, as from this is determined the difference in elevation between the rail head and the pavement surface on the inside of the curve.

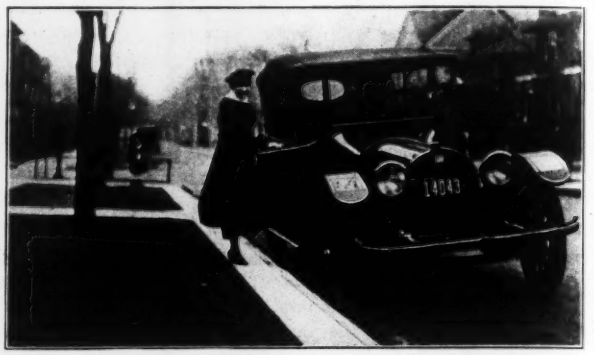
The following are good rules to follow in determining these points: (1) Place the outside rail (*D* in the section) at the elevation it would have were the track on a tangent; (2) in the case of double tracks, give *B* the same elevation as *D*, if there is not much longitudinal grade at the curve. This plan leaves the half of the street on the outside of the curve with its normal crown, and gives the other half a proper slope toward the gutter. If there is much grade, an inlet may be located before the curve is reached, to catch the gutter drainage, so that *D* can be placed even with, if not below, the gutter grade; and *B* will be at the elevation of *C*, with *A* below *B* the amount of the outer elevation. This method results in track drainage for the side of the street at the outside of the curve and thereby eliminates the gutter as a factor in the drainage.



SUGGESTED RELATION OF RAILS, PAVEMENT AND GUTTERS WHERE TRACKS ARE ON CURVE

Walks Along Curb Increase Parking Space

IN THE thickly settled apartment-house districts of Chicago a narrow sidewalk is laid along the curb at the outside of a wide parking, with crosswalks to the main sidewalk at each entrance. The automobile driven by



CURB WALK MAKES CONTINUOUS LANDING PLACE

women is responsible for this arrangement. The car can arrive at any place along the curb, and neither are my lady's slippers soiled nor is American chivalry assailed for lack of a Sir Walter.

Bridge Roadway "Failure" Explained by Bulged Pavement

A police report in St. Louis that part of the deck of the Municipal Bridge had "settled 3 in." on a length of 85 ft. and a width of 4 ft. led to immediate measures to protect the bridge traffic. The "sunken" portion of the floor was roped off. The newspapers published items that the concrete under that portion of the flooring had "sagged," trying to reassure their readers, however, by stating that "the bridge supports are not affected." Blistering of the wood-block pavement is the explanation of the incident. The pavement became soaked in a rainy period, because one of the roadway drains was allowed to choke up. The blocks swelled, and a blister about 6 x 10 ft. appeared. The police decided that the adjoining pavement had settled. One of the city maintenance gangs readjusted the patch of paving in a day.

EDITORIALS

What Can You Do?

EVERY patriotic American is asking himself in these days the question, "What service can I render to my country at this time of crisis?" To only a comparatively few can the opportunity come to render service in the ranks of the country's defenders; but to many millions the opportunity now comes to contribute, according to their means, toward the nation's great task. Without a single dissenting vote the House of Representatives passed the bill under which the nation is to borrow from its own people seven billions of dollars to prosecute the war. With similar unanimity the people should respond with subscriptions to the loan. Let us not forget that in the floating of this great war loan America is on trial. Our enemies have asserted that Americans are a nation of money grabbers, with no patriotic ideals that they are willing to translate into terms of service and sacrifice. Europe is watching the United States to see what response its people will make to this appeal of its Government for their support. To prove that the nation is united in its response to President Wilson's summons to stand firm for the defense of democracy, the response should be overwhelming, not only in the total amount raised, but in the number of subscriptions. Moreover, the response to this call from our Government for funds to fight the war is not only a duty, but an opportunity, an opportunity for the man of small means as well as for the millionaire. The bonds are to be issued in all denominations, so that even the laborer with his small accumulation of savings to provide against a rainy day can subscribe on the same terms as the millionaire and obtain his portion of this safest investment on earth. The rate of interest, 3½%, is about as high as that commanded by the choicest municipal and state bonds recently, and these United States bonds are absolutely free of all taxation, a very important consideration when one realizes that much higher taxes are a certainty of the future. Let every man remember as he takes stock of his resources and decides how much he can lend to his country that in after years he will always be glad to recall that he had some part, in proportion to his means, in this first great effort of the war.

To Ward Off Starvation

THERE is one other duty that should be realized in full measure by every American citizen. It is his duty to contribute in every possible way toward food production and the prevention of food waste. The whole civilized world is nearer to starvation than it has ever been since the dawn of modern history. America must produce a great yield of food in this crop season now just opening, or there may come such a wholesale starvation as will dwarf even the losses of the war. We have in our system of government no organization that can direct the millions of farmers like a great army of soldiers in their task. It would in any event be impossible to create such an organization now in time to be of service. All that can be done is by a general appeal, such as that made by President Wilson in his proclamation of Apr. 15 to arouse every man to do anything in his power to increase this season's food production.

President Wilson assures the farmers that the State and National Governments will do everything possible to aid in securing seed, in securing labor and in facilitating shipment of fertilizers, farm machinery and the final crop. Bankers everywhere are awake to the situation and ready to aid the farmer with capital to an extent never before known. The Legislature of New York on Apr. 16 made an emergency appropriation of $500,000 to increase the production of food on the farms of the state; and by call of the Governor, meetings are to be held on Apr. 21 in every farming community to plan the season's work.

Many of the readers of *Engineering News-Record*, scattered in all parts of the country, are in a position where they may exert an important influence in encouraging and assisting local movements to aid farmers by the loan of capital and by supplying labor. Such work is truly patriotic service. Further, like the investment in the Government loan, investment in farming may be made good business. Nothing is more certain than that the world will pay very high prices for its food this year. Even with the restoration of peace, it will be years, probably, before the world again accumulates that normal surplus of foodstuffs that is its insurance against starvation. A great number of engineers are interested in one way or another in farming operations, and there never was a better time for the application of science and organization to agriculture, with the certainty of an adequate return, than the present.

Irrigate Idle Acres

THE national food resources of the country might be largely increased at this critical period if some means could be found to get under cultivation 750,000 acres of Reclamation Service lands for which water is now available. It is a great pity to let both the land and the water lie idle at a time both should be utilized to the utmost. At present food prices, if this land were in proper cultural shape, it could be made to yield $20,000,000 to $30,000,000 worth of crops every year. It takes time and cultivation to get humus into these desert lands, but that makes all the more urgent an immediate beginning of the task. Besides inertia on the part of some of the settlers, there are various legal and serious financial obstacles to be overcome. Some of the legal obstacles could be easily removed by Congressional action setting aside, until the present emergency passes, such restrictions as limiting water deliveries to 160-acre holdings in one ownership. Others involve private rights that if interfered with might lead to court delays or final prohibitions. The financial difficulties could be lessened, if not entirely removed, by special Federal loans to aid farmers to prepare and plant the land. Not a little could be done if the Reclamation Service were authorized to send agents to the various projects for the purpose of sympathetic, pertinent inquiry and stimulating suggestion. Quick action is imperative to obtain results. The engineers of the Far West know the needs and could render a patriotic service by exerting their energies to awaken local interest and activity as well as to enlist the support of Congress and the executive officers at Washington.

$3340 Saves $1,000,000

THE local meteorologist of the United States Weather Bureau for the upper Tennessee River district estimated that about $1,000,000 worth of property was saved during the recent Tennessee River floods as a result of the warnings issued by the bureau. The actual damage is placed at $469,000. The real saving cannot be closely estimated, of course, and it would be difficult to obtain the actual money value by anything short of a field census.

Assuming the estimate of the Weather Bureau observer to be reasonable, it is of interest to find out the cost of the service on which the warnings were based. Newspaper reports have said $25, but these probably had reference only to the expenses incidental to the local distribution of warnings. Going deeper into the situation, it appears that the annual cost of the Weather Bureau's stations maintained on the Tennessee River in the Chattanooga district and above is $2118. Adding to this the pro rata cost of the river service at the principal Weather Bureau stations in the district, Chattanooga and Knoxville, about $1221, the total approximate cost of the service on the upper Tennessee River is about $3340. This, then, is the sum whose expenditure saved $1,000,000 in this district. The total cost of the river and flood service of the Weather Bureau for the whole United States is $120,000 per annum; hence about eight times this expenditure was saved in a single flood.

Engineers at the Head

THE extent to which the public looks to the engineer as a leader and executive has had remarkable illustration during the past week in the selection of two famous engineers to take charge of the two most important tasks now before the United States. The Council of National Defense has selected, to be the head of the United States Food Board, Herbert C. Hoover, the American mining engineer who has gained international fame by the wonderful success with which he has conducted the work of providing food for the people of Belgium. The other great task before the United States is the production of ships. At the request of President Wilson, Gen. George W. Goethals will take charge of the work of building with the utmost possible dispatch an enormous fleet of wooden ships according to plans already prepared by the United States Shipping Board. The general scheme of building standardized wooden ships at this time when steel for shipbuilding can only be obtained with long delay has been promoted by two engineers, F. A. Eustis, a mining engineer of Boston, and F. Huntington Clark, of New York, and it is stated that they will be associated with General Goethals in the work. It will be recalled also that the Advisory Commission of the Council of National Defense, which is charged with the great task of mobilizing the industrial forces of the nation for the war, has as two of its seven members Howard E. Coffin and Hollis Godfrey, both well-known engineers, while Walter S. Gifford, the director of the commission, is a member of the American Institute of Electrical Engineers. That leadership in these great national enterprises should be intrusted to members of the engineering profession is not only a source of genuine gratification to every engineer, but furnishes a renewed incentive to each engineer to do his utmost, each in his own individual capacity, to forward the great work in which the nation is engaged.

Sites for Garbage Plants

DARK ages of sanitation would speedily return if heed were given to the unreasonable opposition often manifested in the choice of sites for sewage-treatment and garbage-disposal works whenever a new plant of one kind or the other is to be established. A current illustration of this sort of opposition is afforded by the attitude of the citizens of Richmond Borough (Staten Island), New York City, to the proposed building of a plant to treat New York City's garbage on an island near Staten Island.

After attempting to get Governor Whitman to intervene through the State Department of Health and failing in the attempt, attention was turned to the Legislature. Bills were introduced there which would have made it possible for the authorities of any county in New York State to prevent the entry into that county of garbage from any other county. The specific result desired was to force each borough composing New York City to dispose of its garbage within its own limits.

If such a rule would hold as to counties, why not as to cities within a county? If to cities, why not as to wards? If to wards, why not to blocks? If to blocks, why not to individual buildings? That is, carried to its logical end all sewage and garbage would have to be disposed of on the premises where produced even to the extent of disposal within each of the several household divisions of a tenement or apartment house. Enough said.

Vehicle Tunnels Under the Hudson

EVEN the casual user of ferries between Jersey City and New York must be impressed with the inadequacy and inelasticity of the service for carrying vehicles. Extensions to the so-called "five ferries" would not furnish more than a temporary and partial relief, for the very nature of the method makes it subject to interruption by fog, ice and many other natural causes. The day is not far off, if it is not already here, when the very definite limits of available wharfage will set a mark beyond which extension of the ferry service cannot go. Commercial business in the greatest city of the world is being gradually throttled by the unfortunate circumstance that the city is isolated by the identical factor to which much of its growth is traceable. Although the Hudson River furnishes room for hundreds of docks, it also sets its half-mile width of water between New York and the West, on which New York must draw for much of its prosperity.

Definite though futile attention has been given to this particular problem since 1906, when legislation by both New Jersey and New York authorized its study by a commission. But while business has been gradually forced to make use of temporary expedients waiting the slow determination of public action, the Public Service Corporation of New Jersey, with the celerity which may some day be grafted upon governmental functioning, has tackled the situation in the frank realization that traffic relief between the two cities would be to its advantage. The corporation stands ready, if authorized, to undertake the construction of a vehicle tunnel underneath the

Hudson River whenever material and labor prices return to normal.

Besides affording relief to the metropolis, the construction of this highway should make possible rapid commercial development of the vast areas of the Hackensack and Newark meadows, particularly since a tube favors motor traffic, and this modern short-haul method of transport is being developed at a rate that should soon revolutionize the present attitude toward railroad terminals. It is a matter of record that motor-vehicle traffic across the East River bridges is growing at a much faster rate than is horse-drawn traffic, and it is well known that the industrial development of Brooklyn and Long Island City has been concomitant with the construction of the new bridges.

The matter hinges, to an extent perhaps, upon a readjustment of freight rates so that freight billed to Jersey City will not have to carry lighterage charges to New York City. Determination of the equity of this quasi-anomalous situation is in the hands of the Interstate Commerce Commission. This body, unfortunately, has to face the oppositely directed demand of the City of St. Louis, which feels itself discriminated against because East St. Louis is favored with a differential of 20c. a ton on all freight originating within the 50-mile zone.

United Action by Engineers

FOR more than a year past there has been active discussion among leading engineers over plans for coöperation of engineering societies. There has been in existence for a number of years a Joint Conference Committee, made up of representatives from each of the principal national engineering societies. This committee was organized to take action on any matters that were of interest to the whole profession. It has done some important work, such as starting the movement that resulted in the principal national societies underwriting the International Engineering Congress held in San Francisco in 1915. The committee's powers, however, are strictly limited, and an attempt made a year ago to authorize the committee to speak for the societies on questions of public interest was not wholly successful.

There is a widespread demand that engineering organizations should take a more active stand on public questions and that the various societies should coöperate in this work. In recognition of this sentiment a committee representing the four national engineering societies has recently worked out a plan for the organization of a body to be known as the Engineering Council, which is to be a branch of the United Engineering Society. This latter, it will be recalled, is the name of the holding corporation under which the four national societies own and manage the Engineering Societies' Building, on West 39th St., in New York City.

It is proposed that the governing body of each of these societies shall name five members of the Engineering Council, and three members shall be named by the Board of Trustees of the United Engineering Society. While it is proposed at the start to organize the Council with these societies alone represented, the way is left open for representation of other engineering societies on the Council at a later date. Plans for the organization of the Council now await ratification by the governing boards of the four national societies. If no opposition is encountered, the plan will doubtless be carried into effect.

The primary object of the Council is to enable the opinion of the engineering profession to be expressed "on public questions of common interest or concern to engineers." The scheme of organization is elastic enough, however, so that if desired it could eventually take up such matters as coöperation of the societies in plans for their internal conduct, or such other questions as have been discussed by the Coöperative Conference of Engineers, which held its third annual meeting at Chicago last month, under the chairmanship of Prof. F. H. Newell.

It is noteworthy that the Chicago conference adopted a resolution expressing its willingness to turn over its work to the Engineering Council, "provided that body is organized on democratic lines." While the Council is likely to be organized at the start with representation of the four leading national societies only, there is every reason to expect that, after its organization is completed and its plans of work are established, arrangements will be made to admit representatives from other important national societies dealing with engineering or applied science.

Another movement that made considerable progress last year contemplated the organization of a body to be known as the Civic Scientific Alliance, which would have been independent of existing technical societies. A committee was organized in New York to work out the details of this scheme, but has postponed further work until it shall be determined whether the Engineering Council proves successful in filling the recognized need.

Torsional Buckling

A PECULIAR form of failure was shown by some Z-bar columns tested at the Bureau of Standards a short time ago. The columns did not fail by buckling. Instead, the middle of the length of the column twisted axially with respect to the two ends, the ends remaining in original relative positions. Other Z-bar columns of slightly thicker proportions did not fail in this peculiar manner.

The forms of column failure described in our current treatises on mechanics and strength of materials do not include anything that involves twisting action. It is obvious, however, that the twist is the resultant of the buckling tendencies of the four outstanding flanges of the Z-bar columns. When the four separate buckling tendencies are in the same tangential direction, a torsional shear is produced. Under conditions when this deforming shear is large enough to overcome the torsional resistance of the column core, twisting occurs, provided lateral buckling of the entire column has not developed at lower load. The twisting and integral buckling actions bear no relation to each other, since they depend upon different and quite unrelated factors.

Thus, a column may buckle (by torsion) at lower load than is computed by ordinary flexural-buckling formulas. Probably, danger from this cause is not very common. But a more threatening danger, because less obtrusive, is that arising from intermediate connections to a long column, when these are so attached that they may exert a torsional action on the column. A column otherwise safe by a good margin may by such method of connection be brought into danger of sudden failure.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcomed

Shall Portable Buildings Replace Tents in Military Camps?

Sir—With the entrance of the United States into the European War, one of the vital problems to be met is that of sheltering great bodies of men in training camps. A pressing question is, Shall canvas tents give way to portable frame buildings?

In the past our military encampments have been pictured as consisting of neat rows of tents. In fact, would a row of frame buildings ever appear as martial and inspiring? Portable frame buildings, however, are more practicable and may eventually supersede tents, however popular (in the public eye) the latter may be.

To a commander the foremost questions are how to take the best possible care of his men and how to provide for the proper sanitation of the camp. Other questions are details. Therefore the living quarters of the men will be an all-important matter. Developments of fixed encampments in past campaigns have always leaned toward a substitute for tents. In the Philippines bamboo shacks were used; in the recent punitive expedition into Mexico adobe huts were constructed at the first opportunity.

On the face of it, if frame buildings can be constructed as cheaply and equally as portable, except in regard to weight, as canvas tents, there are many advantages in their favor. Chief among these is the possibility of adequate heating and ventilation. If we can judge from methods employed in England, training camps will be maintained throughout all seasons of the year. This will mean that during the cold weather the living quarters, whatever they may be, must be heated. To heat a modern pyramidal squad tent a stove of the type such as is commonly known as a "pot stove," burning either coal or wood, is required. Even at best, to maintain a comfortable temperature during the winter months in a climate such as is prevalent in the central, western or northeastern states is practically impossible. It is customary at present during the winter to build frame sides and board floors for canvas tents where they are used as permanent or semi-permanent living quarters for troops. Does not this practice tend to point toward frame quarters? Would not such retain heat much better? Would they not eliminate much of the dampness? Would not sanitation be better? Would not entrance of thieves be more difficult? Would the quarters not be far less perishable? (The life of a canvas tent, in constant use, may be quoted at six months. A frame building, even were it erected and taken down repeatedly, would last easily from three to five years.)

So, if we admit frame buildings to be more suitable from the point of view of comfort and durability, the comparative costs may next be considered. A pyramidal tent costs $40.21 and is 16 x 16 ft. To each tent is assigned, normally, one squad, or seven men and a corporal. Thus, for an infantry company recruited to full war strength of 150 men, there would be required 18 tents as living quarters only. At a cost of $40.21 a tent the total cost of sheltering such a force would amount to $18 \times \$40.21 = \$723.78$. An additional expense would be one stove to each tent. At $1.28 a stove this would amount to $23.04. Tents are renewed, on an average, after six months of field service. Thus, for a three-year period (which is taken arbitrarily as the life of a portable building under the same conditions), the total cost for tentage for each infantry company would amount to approximately $4370.

An adaptable portable frame building would be 24 x 122 ft. and 9 ft. high at the eaves. Such a building would shelter comfortably 50 men or, let us say, one platoon of infantry. The cost would be approximately $1400. The No. 1 building of each company could have partitions installed at hardly any extra expense, to afford separate living quarters for the sergeants and an office for the company first sergeant. To heat a building of this type during the winter months it would be best to use sheet-iron wood-burning stoves, commonly called "Southern wood burners." Four such stoves would afford ample comfort, and the cost of each would probably be in the neighborhood of $5, totaling $20 a building. Thus, the cost of such a building, erected, without flooring would amount to $1420. At three buildings to a company the total cost would be $4260.

Ease of transportation would favor tentage at present, should this be a pertinent question. A canvas tent can be rolled into a compact bundle about 2 ft. square. On the other hand, the average size of a wall section of a portable building of the area quoted above would be 5 x 9 ft. Such a section could easily be handled by four men. A building such as this would be composed of approximately 58 wall sections, weighing approximately 150 lb. each, and 48 roof sections, 5 x 13 ft., weighing approximately 200 lb. each. The total weight would be 18,300 lb. For three buildings, the total weight would be about 55,000 lb. If standard three-ton auto trucks are used for transportation, nine trucks would be required to carry shelter for a war-strength infantry company.

Portable frame buildings similar to those described are now in use at the army aviation camp at Mineola, L. I., as living quarters for student aviators and enlisted men.

Orange, N. J. ALLEN F. BREWER.

What Is the Military Status of Draftsmen?

Sir—At this late day, and after all this talk of preparedness, it may seem strange that any man should not know to what military group he belongs, but such is the case, not only with myself, but with dozens of other draftsmen—as I discovered only a few days ago.

We have heard much of the scientist, much of the engineer, much of the skilled mechanic, but of the draftsman, nothing. Are we listed with the engineers and as such expected to place ourselves at the disposal of the Government for either peace or war service? Are we listed with the skilled mechanics and expected to stick to our work? Or are we just common, ordinary cannon fodder, entitled to no more consideration in a military scheme than we get in ordinary times?

Perhaps you can enlighten us and prevent many men from getting in wrong, right at the start.

A DRAFTSMAN.

[Draftsmen **need not** fear but that there will be a place for their technical services in the military plans of the nation. Each company of engineer field troops (war strength 164 men) should have about 12 topographical draftsmen and sketchers, of whom three or more should be good instrumentmen, five topographical and mechanical draftsmen and three photographers and blueprinters. The company would have three clerks, who might well be draftsmen also. The navy will require few draftsmen on board ship but, under present conditions, many for shore duty. Men with engineer troops and on board ship are trained as combat forces, of course, and their ability as draftsmen is employed in only part of their service. The production of military and naval supplies by commercial concerns will demand many men. Various needs will arise from time to time for draftsmen, who will be sought out by committees of engineering societies and technical schools, all of which are classifying members and former students for such service. No draftsman need feel, however, that he is failing in his patriotic duty if no call comes to him in any of the fields above outlined, provided he has made his services available to the extent of his ability and with due regard for those dependent upon him. Every businessman, engineer, draftsman and skilled worker who stays at his post to keep the industries of the country humming is doing his bit—to the end that business may continue to yield products and support the heavy financial drain that the war will impose.—Editor.]

What Is a Representative Sample for Testing Concrete Aggregate?

Sir—In an endeavor to determine the variables affecting the sampling of gravel for concrete aggregate and the best means of taking the sample, the writer has conducted a series of tests extending over a period of several years, taking in that time 300 samples of gravel representing some 60,000 cu.yd. of material discharged through bunker to scows. The following conclusions were deduced from the observations:

The amount taken for a gross sample is generally too small, particularly if there is considerable variation in the size of particles.

As the size of sample decreases, the difference between separate samplings becomes greater.

The larger the gross sample the less chance there is of its being nonrepresentative.

The smaller the ratio of sizes the greater is the accuracy of sampling and the smaller the gross sample.

The best time to collect sample is when the gravel is being loaded or unloaded.

The individual samples comprising the gross sample should be taken at different times during the discharge from the bin.

At least 600 lb. drawn in three samples at different times are required to represent fairly a 300-ton shipment. Sampling this same material from a stock pile will require at least 2000 lb. gross sample, quartered and requartered, to obtain the same accuracy as the 600-lb. bin sample.

R. J. BORHEK,
Tacoma, Wash. Tacoma Sand and Gravel Co.

What the Federal Valuation Will Accomplish

Sir—The Federal valuation of the railroads is causing the production of a large amount of literature pro and anti. Much is so intensely partisan as to be repellent. This partisanship blinds its victims to the benefits of the valuation, which an open mind would readily perceive. There is every reason to believe the final outcome will be highly beneficial to all concerned—the public, the employee and last, but not least, the stockholder.

From the stockholder's standpoint there is probably more to be said in favor of the valuation than from the position of any other of the interested parties. One of the loudest protests heard is that the cost is so great. The truth is that a single quarterly dividend on a 6% dividend-paying property would more than pay all the cost. If by the valuation the property is placed on a stable basis and the loss of one dividend is avoided, the stockholder is at least not a loser.

It is sometimes argued that the valuation will cause innocent holders of watered stocks to lose heavily. No system short of revolution and anarchy could be worse for these innocents than the existing one. One receivership and adjustment (usually brought on by shady manipulations or inefficient management) cost the stockholders from ten to a hundred times as much as the valuation.

With the public informed as to the needs of its servant corporations and the atmosphere of suspicion removed, justice will be readily obtained. The American public is willing to pay when it feels that it is getting "value received." It must be noted, also, that a respectable percentage of the public are stockholders. This will be a strong guarantee of fair play.

Many other beneficent reforms will be stimulated by the valuation. Useless, senseless duplications will eventually be prevented. Instead of two rival lines fighting over traffic that is hardly sufficient for one, one line will be permitted a monopoly and required to serve adequately. This will leave the previously wasted capital to open new lines or furnish more and better equipment. Just suppose the capital that has been wasted in duplication in the Northwest and in Canada, during the past 20 years alone, were now invested in terminals, double-tracking and additional equipment. This alone would have gone far toward preventing the crippled condition that has existed for the past eight months and that always occurs when business is heavy.

Would this benefit the stockholders? Without a doubt. The hoary fallacy of competition must die, as applied to public utilities at least. The valuation will help in the execution.

It must be admitted that the process of valuation is as yet wretchedly crude. It is so new an undertaking that it cannot yet be expected to be well adjusted and smoothly operative. Time and experience are working out the difficulties. Constructive criticism will do much more than obstruction toward the solution.

Another development that will come will be the responsibility placed on labor. Eventually, every man who takes employment on any public-service utility will be required to enter upon a contract not unlike an enlistment. He will undertake not to desert his post without knowing a substitute is available, except in case of sickness or other good reason. All grievances will be

heard by a body composed of representatives of the capital, the public and the employees. This action would not destroy the brotherhoods, but would prevent the vicious effects of their present narrow selfishness. The recent disgusting spectacles of organized brigandage could not recur.

The valuation is the means of getting a foundation upon which to build. It is the best means by which capital can rehabilitate itself in the eyes of the public. When this is done, the other reforms will follow. Capital will be assured, labor made responsible and taught reason and the public interests conserved. It is to be hoped that we can avoid government ownership. Under a democratic form of government, inefficiency is the price paid for liberty. This applies in particular to government-owned and government-operated utilities. Private ownership with government regulation and participation in excess profits is as nearly ideal as can be hoped for. It may be a long way ahead of us. Who can say? Other reforms have come with surprising swiftness. As the engineering profession obtains recognition and influence, it should use all its force toward progress.

W. H. Woodbury.

Valuation Engineer, Duluth & Iron Range R.R.

Duluth, Minn.

[Other railroad men engaged in the Federal valuation will of course not be in unanimous agreement with Mr. Woodbury as to the usefulness of the work. We judge, in fact, that he is decidedly in the minority. Inasmuch, however, as the undertaking has gone so far, with no apparent prospects of abandonment, his view seems the sensible one, and railroad officials should concentrate on constructive, not destructive, criticism of the work and its possibilities.—Editor.]

Wanted—Better Laws On Expert Testimony

Sir—The subject of expert testimony, as recently discussed in *Engineering News*, is of particular interest to me and I take this occasion to illustrate the inadequacy of laws governing such testimony.

I have been connected with litigation as an expert in engineering on several occasions and would state that it is a line for which I have very little hankering, for there seems to be no provision in the laws of the states where I have acted, or even in the Federal Courts, for a proper compensation for such service. Take North Carolina and Tennessee, for instance. In the former an attorney may move that a witness giving expert testimony be allowed such compensation as the court may fix as a part of the costs of the case. This he may get if his side wins; otherwise, he gets the regular witness fee of $1 per day, as I did in a recent case here, where one of the attorneys asked for my opinion as an expert. In Tennessee the expert is expected to get his fee out of his client, the court allowing only the regular witness fee of $1 or $1.50 per diem and 10c. mileage from the state line to the county seat.

I appeared in a case there last fall, and the mileage and per diem amounted to $23; I paid out for expenses $22.02. Though the side I appeared for won the case, I am still waiting for my expense money. Still another instance: A few years ago I was appointed court surveyor by the United States District Court in some land litigation and spent a week with a surveyor appointed for the other side, making surveys and preparing plans showing the contentions of the parties. When the case was called, I was a day's journey distant and absorbed in important work that it was difficult for me to leave. My client telegraphed that it was important for me to be there, and I spent three days and over $20 making the trip. The evidence of the other surveyor, who was called first, coincided so well with what I would give that I informed the attorneys for our side of this fact and was not called to the stand. The side I represented won the case; I proved my three days' attendance at $1.50 and mileage, but in fixing the costs my claim was not allowed and I received nothing from the court, though I paid out over $20 in making the trip—to say nothing of the time lost from the work I was on. Of course, I had to look to my client to make up the deficit, and he still owes me part of it. When the costs were settled, the court allowed me $20 for a week's work to cover time and expenses.

I mention these few cases from my own experience to illustrate how inadequate and inefficient are the laws bearing on expert testimony. How can the courts expect to secure honest expert testimony if they do not pay professional men a reasonable fee for appearing, but rather encourage bias in the interest of the client from whom they expect to receive their pay?

How much better it would be if, as has been suggested, the court would appoint disinterested men to present expert testimony and advice to the court. In such case, of course, the witnesses would consider themselves neutral and give their testimony purely from the technical standpoint—stating facts together with their opinion on the points raised, which latter is allowed in expert testimony.

I am in entire accord with the suggestion that the great engineering societies should devote some thought to a solution of this matter, and I think an effort should be made to have legislation enacted looking to this end and having reasonable fees fixed by statute for various classes of expert testimony in the trial of cases.

Benjamin H. Case,

Asheville, N. C. Mining and Civil Engineer.

Columbia Interstate Bridge Was Designed by Waddell & Harrington

Sir—In the article by Frank M. Cortelyou, on page 530 of *Engineering News* of Mar. 29, describing the Columbia River Interstate Bridge, Mr. Cortelyou is described as resident engineer for Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo. In view of the fact that the name of the designing firm is not referred to in the body of the article, this would very possibly lead readers to believe that Harrington, Howard & Ash were the consulting engineers for this bridge. As a matter of fact the bridge was designed in its entirety, and the contract drawings were prepared, in the office of the late firm of Waddell & Harrington, and Mr. Cortelyou has acted throughout the construction of the bridge as resident engineer for the designing firm. J. L. Harrington was in charge of construction for Waddell & Harrington.

F. H. Frankland,

Waddell & Son, Consulting Engineers.

165 Broadway, New York City, Apr. 5, 1917.

HINTS FOR THE CONTRACTOR

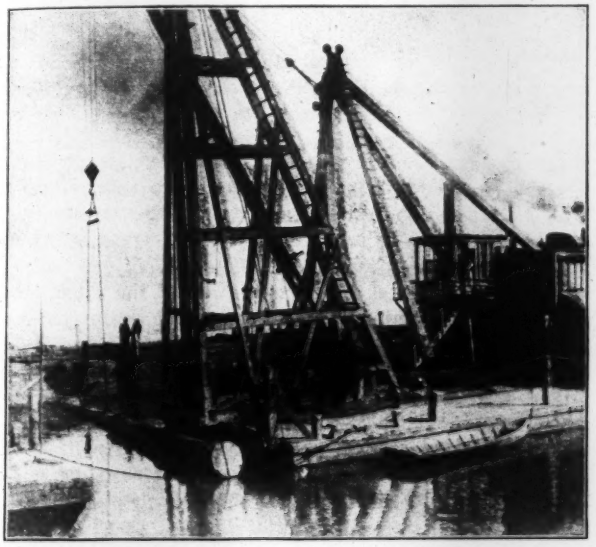
Details Which Save Time and Labor on Construction Work

Diving Saves Cofferdam in Laying 200-Foot Twin Intake Line at Cairo, Ill.

By W. E. DUNSCOMBE
Submarine Diver, St. Louis, Mo.

CONSIDERABLE diving made it possible for the writer to install a twin pipe-line intake under 30 ft. of water in the Ohio River for the Cairo & St. Louis Electric R.R., at Cairo, Ill., without using a cofferdam. The double line of 24-in. cast-iron pipe was laid in a ditch 180 ft. long dredged 16 ft. deep, by a derrick boat.

The material, which was blue clay and quicksand, was removed about 4 ft. below cutoff, after which the piles



THE FLOATING PILE DRIVER WAS USED ALSO FOR LOWERING SECTIONS OF BALL-JOINT PIPE TO PLACE

were driven, four to a bent, the bents spaced 16 ft., or one pipe-length apart, by a floating driver with a follower. Each pile was sawed off under water by the writer, with a one-man crosscut saw; the 12 x 12-in. caps were placed, and blocks were drifted to the caps on both sides of each pipe line. The lengths of pipe were then lowered in place and the joints made under water by the writer. In addition, a 16-pile cluster, cut off 4 in. above the grade of the pipe, was driven around the intake end and braced with planks bolted on under water. Also, two bulkheads across the line of the excavation, one about 80 ft. from shore, 40 ft. long and 16 ft. high, and the other the same height and 20 ft. long, about 10 ft. behind the intake, were built by driving piles and bolting 4 x 10-in. planks to them, to retain the backfill.

Ball-joint pipe was used, two lengths making a section 32 ft. long. The sections were made up on a barge and lowered by the derrick boat and driver, as shown in the photograph. As the quicksand ran into the trench to some extent, plank bulkheads were bolted across the open end of each section before lowering it. Dredging was sometimes necessary after the bents had been capped, before the pipe could be laid; and the bents were marked with floats, so that they could be avoided in digging.

In order not to disturb the last 14 ft. of ground between the river and the concrete intake tower on the bank, two lengths of pipe were jacked for this distance through the earth to connect with each line. A sheet-steel shoe, with a throat inside that allowed a core of earth to pass through the pipe, was attached to the bell end of each section and greatly reduced the resistance to be overcome. The pipe lines were secured to each bent with U-bolts, and the final joint was made under water at the shore end.

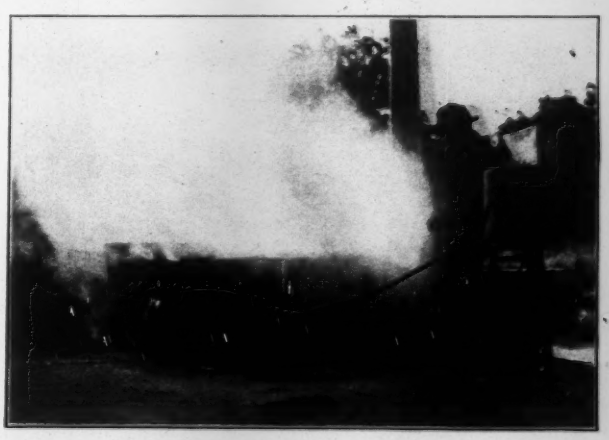
The work was of the type usually done in cofferdams, but the writer finished installing the entire intake in five months, at a considerable saving. The intake was designed and its construction supervised by C. W. Humphrey, consulting engineer, Chicago.

Water and Distillate Mixture Burned in Angle Trough To Heat Road Oil

TO HEAT the road oil required in patching oiled surfaces or on small oiling jobs, such as surfacing a small bridge just being put in service, the Los Angeles County Road Department has been experimenting with a plan for using distillate instead of the ordinary wood fire.

It has been customary on such work to heat the oil in sheet-iron buckets fitted with covers and holding about 4 gal. In the recent experiments these buckets were held by a frame of ¼-in. strap iron, about 8 ft. long, built up of four longitudinal strips on edge, supported about 6 in. above the ground and spaced so that there was room for buckets in two parallel rows. About 30 buckets can be heated on the frame at one time.

Beneath the center of this frame a longitudinal angle iron serves as a trough, into the center of which is admitted a small but steady stream of the mixture of distillate and water, the percentage being about four parts



HEATING MIXTURE FLOWS FROM TANK BY GRAVITY INTO ANGLE-IRON TROUGH

of water to six parts of distillate. The two liquids feed by gravity from two tanks, the admixture taking place at the entrance to the trough.

The theory is that the water serves as a vehicle to support and at the same time spread the distillate, causing the heat of the fire to become effective in a wider zone than would result from burning the distillate alone. In ordinary operation about 20 gal. of distillate are consumed in 8 hours. The buckets heat at a rate such that in about 25 min. the upper half of the oil will be hot enough to be poured off into the tank from which it is pumped hot into the hose that sprays it on the road.

The heating device did not become immediately popular, because it develops a heavy cloud of smoke and there is a considerable deposit of soot, so that the operator usually prefers the wood fire. Nevertheless, the engineers on this work anticipate the improvement of the heater and hope to see it replace the wood-fuel plan where only small quantities of hot oil are required.

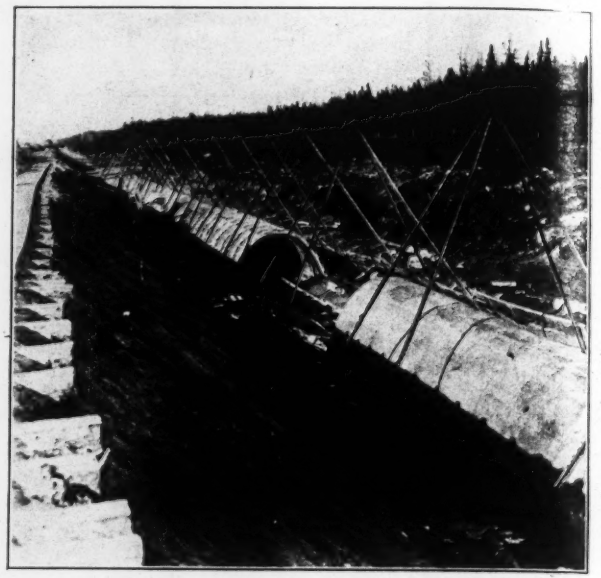
The heater has been developed by the Los Angeles County Road Department, F. H. Joyner, commissioner, Walter Moore, Jr., district engineer, and J. W. McPhearson, foreman. It has been tried out in several of the divisions.

Rail "Tepees" and Plank Keep Fine Material Out of Aqueduct Cut

By WILLIAM SMAILL

Superintendent, Winnipeg Aqueduct Construction Co., Ltd., Winnipeg, Man.

ON ONE portion of the excavation for the easterly part of the Winnipeg aqueduct, described on page 121 of this issue, tepees made of old rails were used to brace across the cut sheeting for retaining soft material cleaned from the trench and to provide sufficient unobstructed space at the same time for carrying on the concrete work and moving the aqueduct forms. The method was used in 1915 near mile 72, where the cut was through a couple of feet of muskeg, 4 or 5 ft. of sandy clay and into a gray hardpan. Because the weather was fairly dry while the dragline machine was making the excavation at this point, no great difficulty was met. However, just before the invert was laid through this section, a spell of wet weather saturated the ground and caused pockets of very fine material in the banks to run out and spread fanwise over the floor of the ditch. From 1½ to 2 ft. of this material had to be removed from the bottom of the ditch. It was of creamy consistency, water would not drain readily from it and it was difficult to handle on shovels.

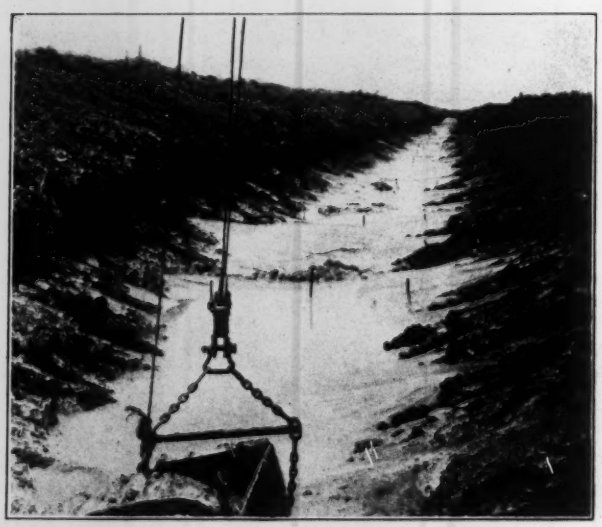


WITH RAIL "TEPEES" AND TIMBER SHEETING IT WAS POSSIBLE TO HOLD BACK THE FINE, FLOWING MATERIAL

As no stakes or sheeting could be driven into the hardpan and as any system of bracing across the trench would have interfered with the handling of forms, the scheme shown in the photograph, suggested by E. Burnell, who was in charge of the camp on this section at the time, was used successfully. Fishplates were bolted to one end of each 20-ft. length of a lot of 20-lb. rails that were on hand. Four of these were set up at a time in the form of a tepee, the ends with the fishplates being on top. The fishplates were tied together with annealed form wire. The bottom ends of the rails in each tepee formed a rectangle in the bottom of the trench, and the tepees set on either side of it were spaced so that the rails on each side of the trench were equidistant from each other all along.

For sheeting to retain the fine material, 2-in. planks were laid horizontally outside the rails, with ends overlapping at or near a rail. These planks were then forced down through the soupy mass to hard bottom. After a stretch of them had been placed on both sides of the trench, moss, of which a good supply grew on top of the muskeg at this point, was shoveled down outside the planks through the muck. This stopped leaks between the planks and the bottom of the ditch. More planks were then placed to raise the barrier high enough to form a low wall on each side, and the fine material, handled in buckets or with shovels, was thrown behind them. This gave an opportunity for the water to drain off, leaving the material more solid.

The sharp edges of the rails just cut into the hardpan enough to prevent slipping. While some of them bent slightly under the loading, this was not serious enough



DURING A WET SPELL MATERIAL FROM SIDES OF DITCH FLOWED OUT INTO THE CENTER, IMPEDING CONCRETING

to interfere with setting the forms or with the movement of the traveler.

The work is being done for the Greater Winnipeg Water District by the Winnipeg Aqueduct Construction Co., for which the writer is in charge.

Contractors Prefer Trace Chains to Clamps for Column Forms

ORDINARY trace chains bolted and tightened with wedges have been found by Pauly & Ipsen, of Springfield, Mo., to be cheaper and handier than the form clamps formerly used on their work for concrete columns. It was found that the trace chains, when bought by the hundred, cost 28c. apiece, while the clamps required to perform the same work done by each chain cost, for the four clamp posts and two rods composing each, 42c. The contractors, who tried this method recently on several two- and three-story structures, state that a column form could be chained in about one-third of the time it takes to adjust a clamp. Time was also saved in stripping; and the time necessary to straighten the clamps, which were often bent, was also saved.

The chains were used by placing around the form four short pieces of 2 x 4's cut to the size of the column and beveled on the ends, around which the trace chain would be bolted and tightened by driving wood wedges between the chains and the 2 x 4's.

Blast Out Blocking To Fell 120-Foot Brick Stack

By W. N. McCRANE
Superintendent, A. H. Tryon, Windsor Locks, Conn.

DYNAMITING out the blocking placed in the notched base made a successful job of felling a large brick chimney at Windsor Locks, Conn. The stack, 10 x 10 ft. at the base and 120 ft. high, was part of the Anchor Paper Mill, which had to be razed after a fire.

HOW CHIMNEY WAS BLOCKED AND FELL

The method of removing part of the base of the chimney, replacing it with blocks and shooting out the blocks proved to be cheap and safe. Three sides of the base were cut out, and 8 x 8-in. blocks were stood on end, as shown in one of the photographs. The brick walls were 16 in. thick, and at the middle of each wall was an 8-in. pilaster extending inward to the outside of the 3-ft. diameter flue, the lining of which was 12 in. thick. After the pilasters and most of the flue lining were cut through, two blocks were placed under the flue. Two of the four pilasters had smoke-pipe holes through them, which weakened them enough to make the cutting a little doubtful; but there was no trouble.

In each of the eight blocks in the main stack wall was bored a 1¾-in. hole, 8 in. from each end. The two holes in each of the corner blocks and one hole in each of the others were loaded with half-sticks of dynamite. The shots were fired simultaneously with a battery, blowing the blocks to pieces and causing the stack to fall just where desired. On the way down the stack broke, as shown in the photograph, the upper part settling down almost straight before tumbling over and landing with its top only 90 ft. from the base. None of the loose bricks went much farther. The pieces of blocking shot out by the blast did not go more than 50 ft.; and not the least damage was done, although a suspension bridge was only 250 ft. away.

The contractor for the work was Andrew H. Tryon, of Hartford, Conn., for whom the writer was in charge as superintendent.

Bore Horizontal Holes Under Crust To Break Up Frozen Ground

IN STEAM-SHOVEL excavation required in frozen ground on grade-crossing-elimination work at Mendenhall, Penn., the Good Roads Construction Co. did some experimenting in blasting the frozen crust. The results indicated that the most efficient method was to bore horizontal holes with an earth auger underneath the crust.

The first attempt at blasting this crust was made by punching holes 4 ft. apart, with bars and hammers, through the 14- to 18-in. layer of frost. A quarter-pound of 60% dynamite was used in each hole, the shots being fired separately with a fuse and cap. It developed that the holes were too far apart and the powder too quick for this class of work, the tendency being to blow out small craters without loosening the entire crust. Du Pont low-freezing farm powder was then substituted and the holes placed closer together, on 3½-ft. centers. The loading was increased to ½ lb. per hole and electric firing adopted. This gave much better results, cracks extending from hole to hole, which enabled the steam shovel to take out the crust in chunks.

The best results, however, were obtained after a face had been developed in front of the shovel by boring horizontal holes with an earth auger at the bottom of the frost line, loading them with ¾ lb. of farm powder each and firing them electrically. These holes appeared to confine the expanding gases better than the vertical holes and to secure the maximum heaving effect of the explosive. It is stated that the crust was more thoroughly broken and the efficiency of the steam shovel increased by this method.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

President Wilson's Appeal to the People

Extracts from Proclamation of April 15 Urging Increase of Country's Productive Forces

The entrance of our own beloved country into the grim and terrible war for democracy and human rights which has shaken the world creates many problems of national life and action which call for immediate consideration and settlement.

We are fighting for what we believe and wish to be the rights of mankind and for the future peace and security of the world. These, then, are the things we must do and do well, besides fighting—the things without which mere fighting would be fruitless.

We must supply abundant food for ourselves and for our armies and our seamen, not only, but also for a large part of the nations with whom we have now made common cause, in whose support and by whose sides we shall be fighting.

We must supply ships by the hundreds out of our shipyards to carry to the other side of the sea, submarines or no submarines, what will every day be needed there and abundant materials out of our fields and our mines and our factories; coal to keep the fires going in ships at sea and in the furnaces of hundreds of factories across the sea; steel out of which to make arms and ammunition both here and there; rails for worn-out railways back of the fighting fronts; locomotives and rolling stock to take the place of those every day going to pieces; mules, horses, cattle for labor and for military service.

It is evident to every thinking man that our industries, on the farms, in the shipyards, in the mines, in the factories, must be made more prolific and more efficient than ever.

The supreme need of our own nation and of the nations with which we are co-operating is an abundance of supplies, and especially of foodstuffs. The importance of an adequate food supply, especially for the present year, is superlative. Without abundant food, alike for the armies and the peoples now at war, the whole great enterprise upon which we have embarked will break down and fail. The world's food reserves are low. Not only during the present emergency, but for some time after peace shall have come, both our own people and a large proportion of the people of Europe must rely upon the harvests of America. Upon the farmers of this country, therefore, in large measure, rests the fate of the war and the fate of the nations. The time is short. It is of the most imperative importance that everything possible be done and done immediately to make sure of large harvests. I call upon young men and old alike and upon the able-bodied boys of the land to accept and act upon this duty—to turn in hosts to the farms and make certain that no pains and no labor is lacking in this great matter.

The Government of the United States and the governments of the several states stand ready to co-operate. This is our opportunity to demonstrate the efficiency of a great democracy, and we shall not fall short of it!

HERBERT C. HOOVER
Chairman of the American Commission for Relief in Belgium, appointed by the Council of National Defense chairman of its Committee on Food Supply and Prices

To the men who run the railways of the country, whether they be managers or operative employees, let me say that the railways are the arteries of the nation's life and that upon them rests the immense responsibility of seeing to it that these arteries suffer no obstruction of any kind. To the shipbuilder let me suggest the thought that the life of the war depends upon him. The food and the war supplies must be carried across the seas no matter how many ships are sent to the bottom. The places of those that go down must be supplied, and supplied at once. To the miner let me say that, if he slackens or fails, armies and statesmen are helpless. The manufacturer does not need to be told, I hope, that the nation looks to him to speed and perfect every process; and I want only to remind his employees that their service is absolutely indispensable.

Everyone who creates or cultivates a garden helps and helps greatly to solve

(Continued on Page 172)

Herbert C. Hoover To Head United States Food Board

Engineer Who Has Handled Belgian Relief Work Selected by Council of National Defense

The Council of National Defense has appointed Herbert C. Hoover chairman of a committee of the council on food supply and prices. This committee is "to report to the council such experiences as European governments have had and to advise as to proper methods of preventing recurrence, so far as practicable, of the evils arising out of speculative prices and to stimulate increased production of all food supplies." Mr. Hoover, who is now in London, will accept the position and return to the United States shortly, continuing his work, however, as chairman of the American Commission for Relief in Belgium. Mr. Hoover has secured the voluntary services of the staff of the American Relief Commission, which has been obliged to evacuate Belgium, and these men will investigate in France, England and Italy the existing food situation, the harvest prospects, import necessities, and methods of regulating food distribution and prices.

In a cable dispatch from London, Mr. Hoover is quoted as saying: "The whole allied world is face to face with a shortage of breadstuffs. If they are to continue to fight, a much larger burden of the food supply must rest upon America. We can at this time put but few soldiers in the field, but every spadeful of earth turned by our farmers, every seed we plant, every ounce of waste we eliminate, is just as much a contribution to the joint cause as that of a man in the trenches. We must increase our production by every device; we must stop waste of every scrap of foodstuff; we must even be prepared to deprive ourselves, if necessary, in order that our allies may be supported. They have eliminated waste and are depriving themselves today, and it is not less our duty than theirs. The war probably will last another year, and from the present outlook of the world's food supply we shall have all we can do by the utmost elimination of waste and the utmost stimulation of production to carry our allies through with their full fighting stamina. Nor can we allow speculation or profiteering to burden our own people with high prices, but we must devise and enforce methods to reduce and maintain more reasonable prices both for our own people and our allies. All these are problems which the American people can solve smoothly and efficiently. Legislation and stringent regulations can accomplish far less than voluntary self-denial and devotion of our people."

Progress Made by Council of National Defense

Its Work Is an Outgrowth of Movement in Which National Engineering Societies Took Leading Part

Work now being done by the Council of National Defense to mobilize the nation's forces for war is an outgrowth of a movement in which the national engineering societies bore a leading part—the formation in the fall of 1915 of the Naval Consulting Board. The members of this board were appointed by Secretary Daniels from nominations made by 11 engineering and scientific societies. Thomas A. Edison was the first president of this board and was succeeded recently by William L. Saunders.

The work accomplished by this board, especially its census of the manufacturing industries of the United States, drew attention to the need of a central authority, established by law, authorized to direct the nation's industrial forces for war work. Congress last year, therefore, established the Council of National Defense, made up of the Secretaries of the War, Navy, Interior, Agriculture, Commerce and Labor departments. The law also provided for an Advisory Commission to the council, made up of seven men chosen for their special abilities and serving without compensation.

It is this Advisory Commission on whom the chief work and responsibility fall, since the other duties of the Cabinet officers leave them little time for the work of the council. The Advisory Commission now consists of Daniel Willard, president of the Baltimore & Ohio R.R., chairman; Howard E. Coffin, vice president of the Hudson Motor Car Co.; Hollis Godfrey, president of Drexel Institute; Samuel Gompers, president of the American Federation of Labor; Julius Rosenwald, president of Sears, Roebuck & Co.; Dr. Franklin H. Martin and Bernard H. Baruch. Walter S. Gifford, of the American Telegraph and Telephone Co., is director of the council, and Grosvenor B. Clarkson is its secretary. Two of the five members of the Advisory Commission, Messrs. Coffin and Godfrey, are engineers, and Director Gifford is also an engineer.

It is this unofficial, unpaid body of business men on whom the responsibility now rests for so directing the Government's great task that united, harmonious and effective work shall be done. The great achievements of the council in securing the supply to the Government of copper and of steel at prices far below the market have been widely heralded, as has also the still greater achievement of securing a truce between capital and labor for the period of the war, so that production may proceed without interruption by strikes.

Its work in many other directions promises to be equally important. The general plan on which the council is proceeding is the formation of subcommittees, each to have charge of a specific line of work.

Of the Committee on Transportation and Communication, Daniel Willard is chairman; and among the other members are Howard Elliott, of the New Haven, and Samuel Rea, of the Pennsylvania. Through the American Railway Association it is planned to operate all the railways of the United States as a single system during the period of the war, so far as all military and governmental uses are concerned.

Of the important Committee on Labor, whose notable achievement is noted above, Samuel Gompers is chairman. Mr. Rosenwald is chairman of a Committee on Clothing, Shoes and Supplies. The Committee on Raw Materials, Minerals and Metals, which has secured low prices for the Government in its purchases, has Bernard Baruch as its chairman. Special subcommittees on brass and on aluminum have been organized to deal with the supply of these materials.

On Apr. 9 a General Munitions Board was organized, with Frank A. Scott, vice president of the Warner & Swasey Co., of Cleveland, as chairman. This board will see to the prompt equipping and arming, with the least disturbance of normal industry, of such military and naval forces as the country may call into service. Other members of the board include six officers of the army and six from the navy; among the latter are Admirals H. H. Rousseau and W. S. Capps. Four members of the Advisory Commission, including Howard Coffin, are also members of this board.

Other committees have been formed on Science and Research, including Engineering and Education, with Dr. Hollis Godfrey, chairman, and Medicine and Sanitation, with Dr. Franklin Godfrey, chairman. One of the tasks which this last committee has undertaken is the standardization of surgical instruments and supplies, and it has caused special courses in military medicine to be established in 50 American medical colleges.

A Board on Commercial Economy has been created, made up of A. W. Shaw, of Chicago, chairman; Edwin S. Jay, of Harvard University, and Wallace D. Simmons, president of the Simmons Hardware Co., of St. Louis. A Motor Transport Committee has been organized, with Alfred Reeves, general manager of the National Automobile Chamber of Commerce, as chairman; other members are Coker F. Clarkson, A. C. Batchelder and Roy D. Chapin.

To take charge of food production and distribution, the council has secured the services of Herbert C. Hoover, head of the American Commission for Relief in Belgium.

While the council has already accomplished most valuable results, its office organization has been unable to handle properly the numerous offers of assistance that have poured in upon it from organizations and individuals in all parts of the United States. Until the new appropriation bills are passed by Congress, funds are not available to expand the council's staff and facilities.

To Aid in Nation's Defense

Each week sees an intensification in the activity of engineering organizations in their efforts to get themselves into a position where they can be of the greatest service during the national crisis—the profession is realizing the manifold ways in which it will do its part during the period of stress.

Make Road Machinery Available

On Mar. 22 the Executive Committee of the Association of State Highway Officials met with Colonel Winslow, of the War Department, to work out a plan by which the association will furnish engineers and road machinery and will co-operate in the construction of roads that will be of specific military value.

At a joint meeting of the local section of the American Society of Civil Engineers and the American Soceity of Mechanical Engineers, held at New Orleans, Monday night, Apr. 2, "Preparedness" was the subject of discussion. Attended not only by the members of the two societies, but by electrical and chemical engineers and army and naval officers, a resolution was adopted requesting President Dusenbury, of the Louisiana Engineering Society, to tender to the Government the services of the technically trained men living in that district. Sidney F. Lewis, C. S. Williamson, Jr., and A. M. Lockett were appointed a committee to put into practical operation the work decided upon at this meeting.

The Kansas Engineering Society, according to its president, H. B. Walker, is ready to "do its bit." The Brooklyn Engineers' Club has passed resolutions of loyalty and indorsement of the principle of universal military service. The Cleveland Engineering Society is taking a census of engineers in Ohio.

To Keep Public Utilities Going

Governor Beekman, of Rhode Island, recognizing the important part that engineers are bound to take in war-time crises, appointed R. W. Adams, acting president of the Providence Engineering Society, as a member of the recently constituted Public Safety Committee, which is taking a prominent part in the preparedness movement. Shortly after this committee was appointed, another and purely engineering committee was constituted with M. H. Bronston, city engineer of Providence, as chairman, who proceeded at once to consider the engineering phases of the situation.

It was immediately recognized by this last committee that the uninterrupted operation of public utilities was probably the most important consideration, and a subcommittee was appointed, consisting of the representatives of the various public utilities and headed by Frank E. Winsor, chief engineer of the Providence Water-Supply Board, to take the matter up. This committee considered that continuity of the water-supplies was most essential from any point of view and made recommendations that an adequate guard be supplied for different

reservoirs throughout the state. This recommendation was sent to the governor, with the result that he called a meeting of the mayors of the various cities, together with political leaders of the House and Senate, all of whom immediately recognized the seriousness of the situation and decided upon legislation that was put through, giving the governor authority at once to establish a state police for the purpose of adequately guarding the water-supply system. This legislation has met with universal favor, and it is a source of satisfaction to the Providence Engineering Society that its efforts were primarily responsible for the passage of the bill.

The Engineering Committee has also undertaken a classification of engineers throughout the State of Rhode Island and now has at hand replies from several hundred men in engineering work, whose services will be available in case of an emergency.

Has Good Effect Upon Community

It is believed that the public spirit and intelligence which have been shown by members of engineering professions in connection with this preparedness work have reacted very favorably upon public opinion and that the standing of the engineers in Providence has been greatly enhanced thereby.

The Illinois Society of Engineers, through E. E. R. Tratman, secretary, has written to the President offering its patriotic support and indorsing the principle of universal national service as a method of increasing the national strength and reliance and assuring the prevention of future international misunderstandings and war. While no other action has been taken by this society, most of its members are members also of other active societies.

Headings Meet in Twin Peaks Tunnel, San Francisco

At noon on Apr. 5, crews working from opposite headings met near the middle of Twin Peaks tunnel, the new municipal bore in San Francisco. The work had been under way 887 days, the total length of the bore being 11,926 ft. Excellent conditions were met during the latter part of the work, no gas or water and firm serpentine rock tending to low percentage of overbreak. The best daily progress was about 30 ft. for the combined main pilot drifts, which were 8 x 8 ft. in section. Seven men worked these drifts in three 8-hour shifts.

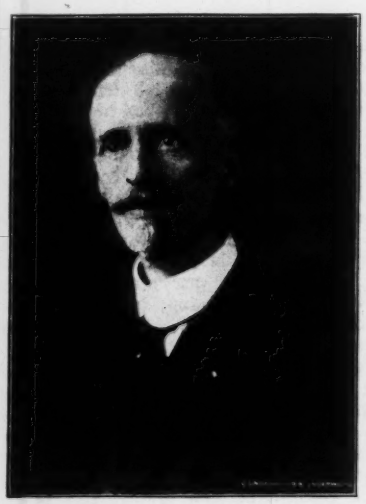
The tunnel has curves at both ends; but there is a long tangent in the middle, and it was possible to check up the alignment through ventilating shafts. A check made where headings met showed an error of ⅛ in. in line and ⅝ in. in grade. It is expected that the wall-plate drifts will be completed about Apr. 18 and that the concreting, which has been kept up close to the heading, will be finished and ready for trackwork by the end of June.

Will Study Engineering Education at Tech

Dr. Charles R. Mann, Head of Committee at Massachusetts Institute To Investigate Curriculum

A thorough study of the problems of engineering education is to be made at Massachusetts Institute of Technology. As noted briefly in last week's issue of "Engineering News-Record," p. 58, a permanent committee, headed by Dr. Charles R. Mann, has been established at the institute to seek means of improving its methods of education. Dr. Mann is soon to issue his final report on the three-year investigation for the Carnegie Foundation for the Advancement of Teaching and has now resigned

Will Study Problems of Engineering Education



CHARLES R. MANN

from the faculty of the University of Chicago, from which he had obtained a leave of absence to conduct the much discussed study of what the successful engineer needs and what the engineering student is getting at the technical schools.

At the beginning of the present academic year President Maclaurin of the institute appointed a permanent research committee from the Technology faculty under the chairmanship of Dr. Noyes, formerly acting president of the institute. The duties of the committee were to deal particularly with the advancement of knowledge. Its suggestions had to do mainly with the promotion of opportunities for advanced study and research work. At the same time it was recognized that the primary function of the institute is to teach.

Dr. Mann, chairman of the committee, will not be called upon to teach and will therefore be free to devote practically his whole time to study of the problems of the committee. He will turn his attention first to entrance requirements.

Boston Engineers in Wartime

In assuming the office of president of the Boston Society of Engineers on Apr. 4, Prof. George C. Whipple, of Harvard University, suggested that in this wartime the regular meetings of the society should be kept up and many special conferences held; that society members must rapidly educate themselves in military engineering and in an appreciation of the military spirit; that the society should stand solidly behind the new regiment of engineers now being organized in New England and, when needful, look well to the care of families of members in action.

"Finally," said Professor Whipple, "it should be remembered that it is the duty of the engineer to keep things going. He serves his country well who does that duty which is most needed and for which he is best fitted—whether in uniform or not. Most engineers can probably be of greatest service by helping to keep the wheels of industry and transportation moving, by seeing that the power is kept up, that supplies are ready when needed, that the railroads and highways are always passable, that the bridges are strong enough to bear unusual loads, that water-supplies remain ample and safe and that the different kinds of engineering work are properly interlocked."

Proposed Roosevelt Division Wants Engineers

Applications are being received at the office of Thomas C. Desmond, consulting engineer, at 110 West 34th St., New York City, for men who desire to enlist or apply for commissions in the Engineer Regiment of the proposed Roosevelt Division to go to France, in case this division is authorized by the Government. Practical men familiar with rough construction work are wanted, particularly bridge carpenters, ironworkers, blasters, shorers, riggers, topographers and railroad-construction men.

Change in Plan of Partly Completed Subway Station

To give the traveling public better facilities, the 42d St. station of the new Broadway subway in New York City, already half constructed, has been ordered changed in accordance with a proposal made by Broadway business interests. This subway is at second level below street, and according to the contract plans was to have two short mezzanine floors between station platform and street, one near 40th St. and one at 42d St. Under the new plan the mezzanine is to be continuous over the whole station area. This will relieve Broadway of a certain amount of foot traffic and also give passengers more direct connection with the adjoining station of the Seventh Ave. subway. The change will cost about $150,000, the Public Service Commission states.

Engineer Reserves in New York To Organize

A committee of officers recently commissioned in the Army Engineer Reserve Corps has undertaken to organize a New York officers' association for promoting the military usefulness of local members. The association would organize a training battalion and an officers' school, etc. William Barclay Parsons is chairman, and F. A. Molitor is secretary of the organization committee.

Detroit Plans $20.000.000 Outlay for Public Works

Increase in City's Area Necessitates Extensive Sewer and Paving Construction Program

As the result of doubling its area within less than two years, the City of Detroit is planning a program of sewer and pavement construction involving a cost of about $20,000,000.

The area of the City of Detroit prior to November, 1915, was 42 square miles. During 1915 and 1916 approximately 31 square miles of territory was added and on Apr. 2, 1917, a total of 8 square miles more, making the present area of Detroit 81 square miles.

Under the immediate head of the city engineer's office comes the work of designing and estimating for the construction of pavements and sewers. With respect to paving, the city plans to let contracts for approximately 170 streets and 150 alleys, at the rate of 10 or 12 per week, until all forced and petitioned streets and alleys are contracted for. Streets averaging 26 ft. in width are to be paved for various lengths, principally with asphaltic concrete, sheet asphalt or brick. The alleys are to be paved with one-course concrete or brick. They average 18 to 20 ft. in width.

Bids for paving streets and alleys (advertised the previous week) will be received on Thursday mornings by the commissioner of the Department of Public Works. The estimated total cost of the new paving is $3,000,000. There will also be some resurfacing and repaving with brick, creosoted block, granite and sheet asphalt. The estimated cost of this work is $750,000.

In outlining the 1917 sewer work, indications are that about one-half of the new territory will be drained by a new system differing from the old in several respects. The sewer system at present consists of main lines and trunks running in a general southerly direction and having their outlet in the Detroit River (see map).

According to a treaty with Great Britain signed in 1909, the pollution of international boundary waters is not permitted. Clarence W. Hubbell, acting then as consulting sanitary expert, conducted an investigation on local sanitary conditions, and as a result it was seen that purification would become obligatory. This investigation was carried on and completed in 1916. Mr. Hubbell, now city engineer of Detroit, will carry out the plans recommended in his report.

Sanitary high- and low-level interceptors will traverse the city in a general easterly and westerly direction, intercepting trunk sewers. Ultimately these interceptors will convey the sanitary sewage to treatment works. The preliminary plan has been made, but the establishment of the various plants will not be attempted for another year.

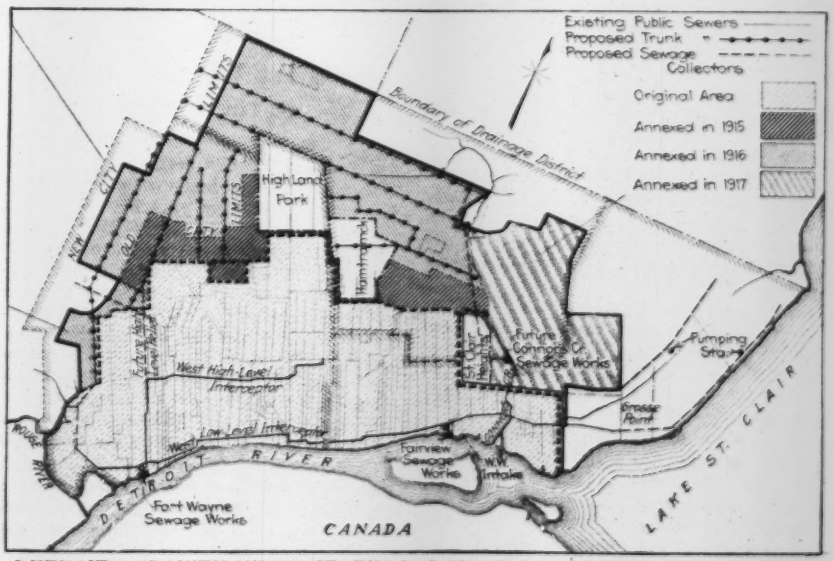
Work To Be Done in 1917

The work to be done this year consists of extending the combined storm and sanitary system to cover all territory now within the city. Four main sewers are proposed for construction in 1917: (1) 7 miles, ranging from 7-ft. cylinder to 13-ft. box; (2) 7 miles, from 7-ft. cylinder to 12-ft. box; (3) 6 miles, from 5-ft. cylinder to 10-ft. box; (4) 20 miles, ranging from a double-barreled outlet, each barrel being a 12 x 13½-ft. box, to 5-ft. cylinders at the upper ends. These are the immediate extensions planned and do not include other intercepting sewers or the many needed relief-sewer extensions that will be built within the next year or two.

The entire sewerage system is designed to care for an ultimate population of 2,600,000. The city has been asked to appropriate $8,500,000 for this work this year. The complete proposed system will cost approximately $16,000,000, exclusive of lateral sewers less than 36 in. in diameter. Probably the city will let contracts in 1917 for approximately 40 to 50 miles of 12- to 36-in. lateral sewers, principally in alleys.

The proposed sewer construction involves no great difficulties, as the stiff blue clay underlying Detroit can easily be tunneled at a low cost. Tunneling machines have been successfully used, for the clay is self-supporting except for occasional small sand pockets encountered in certain restricted areas.

Plans are now being completed for the large trunk sewers, and it is expected that large contracts will be advertised within a few months after the approval of the annual budget by the Common Council about May, 1917.—H. E. Gage, Assistant Engineer, City Engineer's Office, Detroit, Michigan.



DETROIT'S GROWTH NECESSITATES LARGE-SCALE PUBLIC IMPROVEMENTS

Sewage-Treatment Policy for Buffalo District Outlined

A general outline of the policy of sewage disposal that would be satisfactory to Buffalo and Niagara Falls and the village of La Salle has been outlined by a commission of expert engineers for submission to the International Joint Commission of the United States and Canada. That body has control, among other things, of the pollution of interstate waters.

Some time ago the commission made a preliminary report dealing with what it considered would be desirable in the way of treatment of the sewage of Buffalo and Niagara Falls. It was requested that the municipalities make a statement of their attitude on the recommendations of the commission. For that purpose Rudolph Hering, of New York City, Harrison P. Eddy, of Boston, and George W. Fuller, of New York City, were engaged. These advisers have outlined a general policy satisfactory to the two cities, but it will be discussed with the International Joint Commission before formal adoption. The policy suggested is in harmony with the outlined policy of the commission, but presents some modifications, particularly as to the determination of any fixed standard for the reduction of pollution—this in view of the rapidly changing sanitary ideas as to a proper standard.

Five Men Will Direct Railways During War

Representatives of the American Railway Association, including the presidents of the leading roads of the country, met in New York City on Apr. 12 at the call of the Council of National Defense and named a board of five men to direct the operation of American railways throughout the war. Members of the board are Fairfax Harrison, of the Southern Ry., chairman; Howard Elliott, of the New York, New Haven & Hartford; Samuel Rea, of the Pennsylvania; Hale Holden, of the Chicago, Burlington & Quincy; and Julius Kruttschnitt, of the Southern Pacific. Daniel Willard, of the Baltimore & Ohio, who is also chairman of the Defense Council's Advisory Commission, will be an ex officio member of the board. The Interstate Commerce Commission will be asked to name another member.

Mr. Harrison announces that the general committee will be divided into six departments, each to correspond with one of the military departments of the army. The six subcommittees will include 28 railway executives, whose work will be supervised by the central executive committee of five.

Navy Wants Civil Engineers

The present emergency has led the United States Navy Department, through its Bureau of Yards and Docks, once more to attempt to fill the Corps of Civil Engineers through examinations open to young technical graduates. Some years ago this method of filling the corps was abandoned because of various reasons, and the graduates of the United States Naval Academy were drawn on for the requisite annual addition to the land engineering forces of the navy. Announcement has now been made that up to May 8, 1917, applications for an examination to the appointment of assistant civil engineer will be received at the Navy Department at Washington.

All who contemplate or desire to take this examination should write immediately to the Bureau of Yards and Docks at Washington for its circular giving information on the requirements and duties of the corps. In general, the examination is open to young (under 26) unmarried American graduates of technical schools, who have had not less than 18 months' professional experience since graduation. The preliminary examination, which must be in by May 8, is merely filling out certain questions as to qualifications. The final examination is a five-day written test on subjects connected with general engineering practice.

The members of the Corps of Civil Engineers are commissioned officers of the United States Navy, with all the ranks and perquisites appertaining thereto. Their initial pay is $2000 per year with a $552 yearly allowance for quarters, heat and light. They may advance through the various grades to the rank of rear admiral, which pays approximately $9500 a year, and they are retired at 64 years of age with three-fourths pay of their rank. The usual sick benefits, leaves and pensions go with the office.

The duty of the corps is in general the design and construction of the public works and the naval establishment on shore, a most important, interesting and busy work. We are informed by Rear Admiral Harris, the chief of the Bureau of Yards and Docks, that the present number of vacancies is six, but under existing conditions it is quite probable that two or three times this number will be commissioned, provided satisfactory material is available.

Officers Selected for New York Engineer Regiment

The following officers of the Engineer Officers' Reserve Corps have been assigned to the First Reserve Engineers: Majs. W. B. Parsons and A. S. Dwight, Captains G. H. Gifford, J. P. Hogan, H. W. Hudson and J. D. Irving, First Lieutenants J. M. Marshall, Jr., E. K. Carley and C. W. Wilder, and Second Lieutenants F. W. Tourner and C. M. Anderson.

Racine Will Pay Water Company $1,015,000

After a long contest, $1,015,000 has been fixed by the Wisconsin Railroad Commission as the price to be paid by the City of Racine for the water-works of the Racine Water Co. The engineers of the commission valued the property as of Jan. 1, 1914, at $1,007,021 reproduction cost new, or $929,846 less depreciation. The commission disallowed paving over mains and some other items, bringing the engineers' figures down to $915,533 and $836,530 respectively. Plant additions to Mar. 1, 1917, and other allowances bring the total to $1,015,000—which is less than the outstanding bonds of the company.

President Wilson's Appeal to the People

(Continued from Page 168)

the problem of the feeding of the nations; and every housewife who practices strict economy puts herself in the ranks of those who serve the nation. This is the time for America to correct her unpardonable fault of wastefulness and extravagance. Let every man and every woman assume the duty of careful, provident use and expenditure as a public duty, as a dictate of patriotism which no one can now expect ever to be excused or forgiven for ignoring.

I hope that this statement of the needs of the nation and of the world in this hour of supreme crisis may stimulate those to whom it comes and remind all who need reminder of the solemn duties of a time such as the world has never seen before.

WOODROW WILSON.

Class Journals Pledge Their Aid to Government

At a meeting of editors of technical and trade journals in New York City on Apr. 16, the following resolution was unanimously adopted:

"The members of the Editorial Conference of the class journals of New York City here assembled are glad to respond to President Wilson's appeal in his proclamation of Apr. 15 and will do all in their power to lead and inspire the industries they represent to render that patriotic service to the Nation which the President has requested."

The publishers of a large proportion of the technical and trade journals of the United States on Apr. 17 tendered to the Council of National Defense editorial co-operation and free advertising space to further the Government's work in financing the war and mobilizing the country's industries.

Urge Federal, Not State, Control for Engineer Troops

The Military Engineering Committee of New York, representing in its membership the national engineering societies of the United States, is urging engineers to secure the support of their senators and representatives for the following resolution, passed at the committee's meeting of Apr. 12:

"Whereas, In any large army to be created for the war, engineer troops will be needed in large numbers; and

"Whereas, They should be officered by skilled engineers only; and

"Whereas, The composition and training of such troops differ so much from the composition and training of non-technical troops that they should be organized under one central authority rather than under many scattered authorities; now, therefore, be it

"Resolved, That the members of the Senate and House of Representatives be requested to insist that all new units of engineer troops be organized and maintained by the War Department and not by the individual states."

To Build Concrete Shipways 990 Feet Long at Fore River

Concrete ways 990 ft. long will be built by the Fore River Shipbuilding Corporation to handle one of the new battle cruisers recently authorized by Congress. For the foundation, supporting crib, blocks and launching ways over 12,000 cu.yd. of concrete and 3000 wooden piles will be required, while 3000 tons of structural steel will be placed in the 870-ft. craneways. There will be one 50-ton and three 7½-ton electric cranes, all of 120-ft. span, the big crane running 121 ft. above mean low water.

While the Aberthaw Construction Co. is pushing this preliminary construction—which will cost $500,000—shop work on the cruiser is going forward. The ways should be ready for the keel by Sept. 1.

Something New at Water-Works Meeting

A new feature of this year's convention of the American Water-Works Association at Richmond, Va., May 7 to 11, will be an exhibit under the direction of the City Planning Committee, E. P. Goodrich, chairman, 35 Nassau St., New York City. The committee desires photographs and other reproductions of water-works structures, both "artistic and inartistic." The designs should be accompanied by short descriptions and a statement of the "extra costs which were or would be involved in making the designs artistic."

Canadian Towns Join in Water and Sewer Project

Morris Knowles Submits Plans and Suggests Basis of Distributing First Cost and Operating Expense

The Essex Border Utilities Commission, created in 1916 to provide joint water-supply and sewerage facilities for Windsor, Walkerville, Ford City, Sandwich, Sandwich West and Ojibway, Ont., has approved recommendations to that end made by its consulting engineer, Morris Knowles, Pittsburgh, Penn. For works sufficient to 1930 the estimated construction cost is $1,890,000 for water and $900,000 for sewerage, with corresponding annual charges of $209,200 and $101,100.

Mr. Knowles' plans provide for an ultimate joint water-pumping station and purification plant with an intake located in the Detroit River just off the west end of Peach Island, not far from the water intake of Detroit, Mich., but on the Canadian side of the river. From this plant a 24-in. trunk main and smaller branches would extend through the various cities and towns named. The ultimate joint sewerage system would include intercepting sewers and a single treatment plant consisting of some kind of tanks and disinfection works.

For the immediate future the program is simpler and less extensive. The existing water-works pumping station and new 20-in. pipe line owned by Windsor would be utilized by an arrangement under which the commission would compensate the city named, and the pipe line would be extended through Sandwich and Sandwich West to Ojibway. The commission would supply water to Sandwich, Sandwich West and Ojibway at cost, but each of these municipalities would control its distribution system and have all dealings with consumers. As soon as "economic conditions permit," the commission would build the pumping station and water-treatment works at Peach Island. If by that time Ford City and Walkerville wished to secure control of the private distribution system within their limits, the commission might then acquire the corresponding supply works.

The sewerage program would begin with the construction by Ford City of a sewerage system already designed by T. Aird Murray. Sanitary sewers would be built for Ojibway and perhaps for Sandwich West. All sewage now discharged above water intakes in the district would be diverted to a point below. Ultimately, interceptors and pumping stations would deliver all the sewage of the district to a joint pumping and treatment works. As to the latter, Mr. Knowles recommends: "That the sewage-treatment works be built when required by the conditions existing in the river or by the action of governmental authorities."

Mr. Knowles recommends that if necessary legislation can be secured the construction cost should be met by district bonds, all the annual charges to be apportioned and reapportioned from time to time in accordance with existing conditions between the several municipalities composing the district. Pending such legislation, a distribution of first cost and operating expenses among the various municipalities has been worked out by Mr. Knowles.

Dismiss Case Against Chicago Paving Inspectors

Charges based upon the report of Prof. Ira O. Baker to the Finance Committee of the Chicago City Council with reference to paving conditions and filed against eight inspectors for the Board of Local Improvements were dismissed Mar. 28. A special trial board was appointed by the Civil Service Commission to hear the case. Its members were: J. Lee Allen, secretary of the Fulton Asphalt Co.; J. A. Ross, president of J. H. Ross & Co., cement contractors, and Joseph J. Sullivan, chief assistant city attorney.

In dismissing the charges of incompetency and inefficiency, neglect of duty and making false official reports, the board stated that it was guided by the following three things:

"1. The almost daily inspection by the engineers of the Chicago Association of Commerce, a disinterested public body, who found the work done on the streets of Chicago in 1916 according to plans and specifications.

"2. The evidence of the Association of Commerce's engineers that the city paving inspectors always aided and assisted them in correcting any irregularities found in paving jobs. This was coupled with the long and honorable service most of these inspectors had given the city.

"3. The motive apparently back of the investigation of the said staff of the Finance Committee. From the evidence introduced it appears that the staff's investigators discovered in August, while the work was going on, what they considered improper paving, yet nothing was done to correct these alleged irregularities except to make a memorandum and file it away for a future report, until Nov. 2, 1916, long after all the work had been completed, when the Board of Local Improvements' attention was first called to this memorandum.

"It also appears from the evidence that in summaries of the staff investigators' field books, given Professor Baker, notes benefiting the contractors were eliminated from these summaries and only notes from the field books finding fault in the contractors' work were included. This, together with erroneous information given Professor Baker on the general condition of all paving done during the year 1916, leads this board to place greater credence in the unbiased investigations and reports of the Chicago Association of Commerce. . . ."

General Goethals To Supervise Ship Building as Well as Roads

Governor Edge, of New Jersey, has expressed confidence that the proposed system of state highways will be built under the direction of Gen. George W. Goethals, notwithstanding that his services have been requisitioned by the President to supervise the construction of a merchant marine designed to elude the activities of German submarines. The Governor, at the same time, announced that New Jersey would acquiesce in any plans which the Federal Government may have for General Goethals.

Pending a trip he will make to Washington, General Goethals has found it necessary to postpone his inspections of roads in New Jersey. Whether these will be resumed in the near future will depend upon what occurs during the Washington conference.

Outlining the position of New Jersey as regards General Goethals, Governor Edge said:

"If the Federal Government needs General Goethals in any capacity in the interest of public defense New Jersey will gladly acquiesce, and, in fact, I have already so advised the general. Such a possibility was contemplated when the services of General Goethals was secured for New Jersey.

"However, it seems quite possible, so far as I can understand the situation now, that General Goethals may be able to carry out the wishes of the Federal Government and at the same time continue the organization work for New Jersey."

Thacher Bridge Patent Loses in Court of Appeals

The decision against the well-known Thacher patent (No. 617,615) for a "new and useful improvement in concrete arches," handed down by Judge Hale, of the United States District Court, District of Maine, on June 27, 1916, has been sustained in the United States Court of Appeals for the First Circuit in a decision by Justice Dodge, rendered Apr. 6, 1917.

The bridge in question is a 160-ft. twin-rib reinforced-concrete arch, the ribs being reinforced with upper and lower rows of ¾-in. rods tied together every 3 ft. with so-called hoops of ½-in. rod and vertical so-called binders of

¾-in. rods. The main defense of the Town of Falmouth, Maine, defendant in the case, was the 75-ft. Monier bridge tested by the Austrian Society of Engineers and Architects in 1895. This bridge had upper and lower reinforcements of ½-in. "wire" mesh.

The decision of the Circuit Court judge, upheld by the Court of Appeals, was that this construction anticipated the Thacher type of construction, which consists only of longitudinal rods. The Court of Appeals' decision emphasizes the lower court's, which reads: "Variations of size of wires do not constitute invention; widening the spaces between the bars, to enable an engineer to use coarse concrete, is not invention; dispensing in whole or in part with unessential parts is not invention; introducing economy in bridge building by consolidating numerous small bars into one large bar cannot be said to be invention. These things are mechanical; they relate to good engineering; they do not disclose inventive thought."

Million-Dollar Irrigation Project

The largest construction project reported thus far from San Diego County, California, is that of the San Dieguito Mutual Water Co. A 110-ft. concrete dam near Escondido would store 36,000 acre-feet. A five-mile conduit would lead to a distributing reservoir near Del Mar, from which 10,000 acres would be irrigated. It is expected that construction will be started in 1917 and water delivery begun in 1918. Ed Fletcher is president and W. S. Post is chief engineer of the company, with offices in San Diego.

Personal Notes

P. M. Payne, formerly assistant engineer, has been made civil engineer of Clayton County, Iowa.

Samuel J. Mason, former city engineer of Perth Amboy, N. J., has been appointed superintendent of waterworks.

H. Stanley, engineer of roadway of the Charlotte Harbor & Northern Ry., has moved his office from Boca Grande to Arcadia, Florida.

C. E. Nagle has been appointed chief engineer of the Louisiana & Pine Bluff Ry., with headquarters at Huttig, Ark. He succeeds W. H. Lee.

A. T. Thompson, of Chippewa Falls, Wis., has been appointed city engineer and superintendent of public works of Grand Rapids, Wisconsin.

E. B. Eppes, chief engineer of the Georgia & Florida Ry., at Augusta, Ga., has had his authority extended over the Augusta Southern Railroad.

Charles A. Stelle, recently connected with the Kansas City Terminal Ry., is now assistant engineer with the Pittsburgh & West Virginia Railroad.

John Mavity has resigned as city engineer of Wellington, Kan. He was formerly city engineer and county surveyor at Lyndon, Osage County, Kansas.

Daniel L. Turner, acting chief engineer of the New York Public Service Commission, First District, has been appointed chief engineer, at an annual salary of $15,000.

John G. Schmidt, formerly city engineer of Norwood, Ohio, has been engaged by Warren Brothers Co. as sales manager, with headquarters in the Otis Building, Chicago.

Oscar F. Dalstrom, for the past seven years chief draftsman of the Chicago & Northwestern Ry., has been appointed bridge engineer with headquarters at Chicago, Ill.

W. A. Rowell, formerly assistant city engineer and at one time assistant engineer with the New York State Highway Department, is now city engineer of Rensselaer, N. Y.

Earle E. Porter, formerly city engineer of Uniontown, Penn., has resigned to accept a position in the engineering department of the Youngstown Sheet Metal and Tube Company.

A. M. Currier, assistant engineer of the New York Central Lines West of Buffalo, at Cleveland, has been appointed principal assistant engineer, with headquarters in the same city.

S. L. Miller has left the employ of the Illinois State Highway Department at Springfield, Ill., and is engaged on pier-protection construction work for the Wabash R.R. at Hannibal, Missouri.

Ben. L. Allen has succeeded U. S. Yantis as superintendent and treasurer of the Colorado, Kansas & Oklahoma R.R. Mr. Allen was formerly chief engineer with offices at Scott City, Kansas.

W. S. Gearhart, of the Kansas State Agricultural College, for several years state highway engineer, has been reappointed to that position under the new law, by the State Highway Commissioners.

Noah Johnson, assistant engineer at St. Louis of the Wabash R.R., has been appointed engineer of maintenance-of-way of the Peru Division, with office at Peru, Ind. He succeeds **R. S. Charles**, resigned.

W. H. Warnock, who has been for the past ten years with the Board of Water Supply, New York City, has been transferred to the assistant engineer's position, Bureau of Fire Prevention, New York City.

L. G. Burrell has resigned as bridge engineer of Wyoming County, West Virginia, to become district engineer in charge of macadam-road construction in Barker District, Barbour County, of that state.

William Gerig, of Little Rock, Ark., has been appointed consulting engineer for the Alaskan Engineering Commission, with special regard to the improvement of harbor facilities at Anchorage.

W. M. Jaekel, division engineer of the Southern Pacific Co., at Bakersfield, Calif., has been transferred to Los Angeles to succeed A. T. Mercier. J. P. **Edwards** will succeed Mr. Jaekel at Bakersfield.

William Walker has been made acting division engineer of the Grand Trunk eastern lines, with office at Montreal. He takes the place of **F. L. C. Bond**, who recently enlisted for overseas service.

George W. McAlpin, junior engineer, United States War Department, has been transferred from dam 35 and placed in charge of the engineering work on dam 39, Ohio River, near Florence, Indiana.

A. R. W. Sperry, for several years in charge of irrigation works of the Natomas Consolidated Company, California, has been appointed chief engineer of the Anderson-Cottonwood Irrigation district.

O. C. Badger has been transferred to the bridge department of the Atchison, Topeka & Santa Fe Railway, with headquarters in Chicago. He was formerly employed in the maintenance-of-way and valuation departments.

C. S. Pratt, formerly city engineer of Urbana, Ohio, for twelve years and for the last four years engaged in street paving and road construction in various parts of Ohio, has gone with the New Jersey state highway department.

W. Trapnell, district engineer of maintenance-of-way of the Baltimore & Ohio R.R., at Wheeling, W. Va., has been made chief engineer and superintendent of the Coal and Coke Ry., with headquarters at Elkins, West Virginia.

J. G. Scrugham has been appointed state engineer of Nevada to succeed William Kearney, who has held the position for the last five years. Mr. Scrugham was dean of the mechanical school at the State University at the time of his appointment.

H. D. Squire has been appointed assistant engineer of the California State Harbor Commission. He was formerly construction engineer with the San Francisco Bridge Company, in charge of construction on the Hunter's Point drydock at San Francisco.

Paul Witherspoon, district bridge inspector of the Pittsburgh Division, Baltimore & Ohio R.R., at Pittsburgh, has been promoted to assistant division engineer and supervisor of the Staten Island Lines. His headquarters will be at St. George, Staten Island, New York.

Carlile P. Winslow has been appointed director of the Forest Products Laboratory, at Madison, Wis., to succeed Howard F. Weiss. Mr. Winslow entered the Forest Service in 1908 and since then has been engaged in research work in forest products. For the past four years he has acted as assistant to the director of the laboratory.

C. R. Diemar, assistant engineer in the office of the district engineer of maintenance-of-way, Cincinnati, Hamilton & Dayton Ry., at Cincinnati, has been made division engineer of the Newark Division of the Baltimore & Ohio R.R., with headquarters at Newark, Ohio. John Mayer, assistant division engineer of the Baltimore & Ohio, at Chillicothe, Ohio, succeeds Mr. Diemar.

W. J. Fulton has been promoted from city engineer to president of the Board of Public Works of Gary, Ind.; W. P. Cottingham has been promoted from assistant city engineer to city engineer. Previous to his engagement as assistant engineer in Gary, Mr. Cottingham served as city engineer for two years in Toppenish, Wash. H. E. Jordan has been transferred from assistant engineer to superintendent of parks; O. B. Canaday has been promoted to assistant engineer; Ray D. Hammons has been transferred from chief draftsman to assistant engineer.

Oscar Perry Crosby, formerly general superintendent of the Sprague Electric Railway and Motor Co. and of the Railway Department of the General Electric Co., has been nominated by President Wilson as Assistant Secretary of the United States Treasury. Mr. Crosby, who has been closely identified also with the development of Washington public utilities, has recently become a major in the Officers' Reserve Corps, and the Government has agreed to allow him to serve with the engineers instead of as Assistant Secretary of the Treasury in case of military necessity.

Alexander W. Graham, of Kansas City, formerly connected with the firm of Waddell & Harrington, has recently been appointed chief engineer of the Missouri State Highway Commission. He was second engineer in charge of the construction of the North Kansas City Bridge and was connected also for some time with the Jackson County engineering force, having charge of all rock-road building. Later he was chief engineer for the Park Board of Kansas City. Mr. Graham will have under his direction the expenditure of the $12,000,000 bond issue for Missouri state roads.

E. E. Chadwick, who has been for the last three years in the Engineering Department of the Chicago Great Western R.R., has resigned to accept the appointment of assistant engineer on filter design and construction for the Minneapolis Water Department. While with the railroad Mr. Chadwick had charge of construction of concrete work and buildings on the entire system and was field pilot to the valuation party of the Interstate Commerce Commission when the Government valued the property of that railroad. Previous to his employment with the Chicago Great Western, Mr. Chadwick was in the service of the Chicago, Minneapolis & St. Paul R.R. in its Bridge and Building Department and as assistant to the construction engineer.

Ralph N. Begien, chief engineer of the Baltimore & Ohio R.R., has been promoted to general manager of the Eastern lines, with headquarters at Baltimore. Mr. Begien's early work, after graduation from Harvard University in 1897, was largely in the tropics, where he spent three years with the Nicaragua Canal Commission and a year on railroad work in Ecuador. He entered the employ of the Baltimore & Ohio as assistant engineer in 1902. In 1908 he was promoted to division engineer. Two years later he became assistant to A. W. Thompson, then chief engineer. When Mr. Thompson was advanced to general manager and then to third vice-president, Mr. Begien followed as assistant. Late in 1912, Mr. Begien was made assistant general superintendent of the main-line system and a few months later became general superintendent of the Baltimore & Ohio Southwestern. His return to engineering proved brief, as it was only last summer that he succeeded F. L. Stuart as chief engineer. His photograph was published at that time in the "Engineering Record" of July 8, 1916, p. 61, and "Engineering News" of July 20, 1916, p. 138.

Obituary

T. A. Hay, formerly chief engineer of the Midland Ry. of Manitoba and later city engineer of Peterboro, Ont., died in that city recently at 68 years of age.

Edward J. Haddock, for the past two years in charge of the engineering department of the Edgewater Steel Co., at Oakmont, Penn., died in the Pittsburgh Hospital on Apr. 11. He was born in New York City and was 48 years of age.

Winfield S. Reh, a junior assistant engineer of the Public Service Commission of New York City, died at the Metropolitan Hospital, on Apr. 8, as a result of an explosion of dynamite in the new subway shaft on Blackwell's Island, on Apr. 7.

Horace Granville Scofield, for 37 years city engineer of Bridgeport, Conn., died at his home in that city on Apr. 9. He was chief engineer of the New York, New Haven & Hartford R.R. when he resigned, in 1868, to become city engineer. He served in that position until 1915.

Edward T. Wright, M. Am. Soc. C. E., civil and consulting engineer, city engineer of San Gabriel, Calif., died at his home in Los Angeles, on Mar. 29, after a long illness. Mr. Wright was 65 years of age and had been a resident of Los Angeles for 42 years. At one time he was county surveyor of Los Angeles County.

Erle Leroy Veuve, civil and consulting engineer, of Los Angeles, Calif., died at his home in that city on Mar. 25, at 40 years of age. Mr. Veuve received his engineering education at Leland Stanford Jr. University. He was at one time an assistant engineer for the Pacific Electric Ry. and located most of the interurban lines of that road. For the past 10 years he had been engaged in private practice, and recently was associated with Archibald M. Strong, with offices in the Union Oil Building.

George W. Weed, a well-known engineer and manufacturer, during most of his career identified with the Morgan Iron Works, of which he became president at the time of its reorganization, died at his home in New York City, on Apr. 7. He was born at Danbury, Conn., 78 years ago. Mr. Weed was a charter member and vice president of the Society of Naval Architects and Marine Engineers and a governor and treasurer of the Engineers' Club. He also held official positions in several large industrial and banking concerns.

Arthur Brown, a railway engineer noted for his work as a pioneer in the West during the early days of railway construction there, died at his home in Oakland, Calif., on Mar. 16, at 86 years of age. Mr. Brown was born in Scotland. In the sixties he went to California and entered the employ of the Central Pacific as superintendent of bridges and buildings, remaining in that capacity with that road and its successor, the Southern Pacific, for 35 years. He constructed nearly all the bridges and buildings of the northern and southern branches of the Southern Pacific Company.

Henri Bazin, eminent hydraulic engineer, died at Dijon, France, on Feb. 14, 1917, at the age of 87. He lived at Dijon (where his famous hydraulic studies had been made), but he had retired from professional work many years ago. He was a graduate of the Ecole des Ponts et Chaussees and a member of the Corps des Ponts et Chaussees. Up to the age of 26 he had engaged mostly in mathematical research, but then (about 1856) he was detailed as Darcy's assistant in the hydraulic studies being made at Dijon. When Darcy retired because of ill health, the experiments were continued by Bazin.

Ambrose Edwin Lehman, consulting engineer, of Philadelphia, Penn., died at his home in that city on Apr. 5. He was born in Lebanon, Penn., 65 years ago. At the beginning of his career, Mr. Lehman was engaged on the topographical work of the second geological survey of Pennsylvania. In 1882 he became assistant engineer of the Interoceanic Ry. of Mexico, in which country he made extensive surveys and railroad location. Later he was chief engineer of the Gettysburg & Harrisburg R.R. and of the Brooklyn, Bath & Coney Island R.R. He was connected with the development of the Great Falls Water Power Co., in North Carolina, and for the last 30 years had maintained consulting engineering offices in Philadelphia.

Appliances and Materials

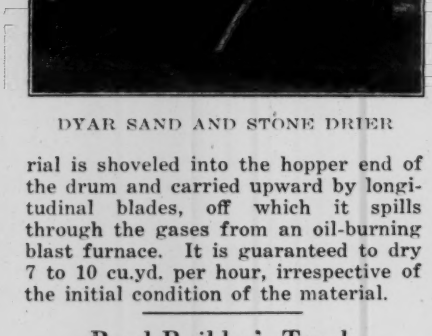
Portable Sand and Stone Drier

A portable mechanical stone and sand drier has been built in recent months by the Dyar Supply Co., 66 Broadway, Cambridge, Mass. The machine weighs 5400 lb. and consists of a revolving drum 3 ft. in diameter and 20 ft. long, mounted with driving engine (6-hp. steam, or 8-hp. gas) on a wheeled or skid frame 23 ft. long over all. Material is shoveled into the hopper end of the drum and carried upward by longitudinal blades, off which it spills through the gases from an oil-burning blast furnace. It is guaranteed to dry 7 to 10 cu.yd. per hour, irrespective of the initial condition of the material.

DYAR SAND AND STONE DRIER

Road Builder's Truck

The Garford Motor Co., of Lima, Ohio, has put out a new model of truck known as the "Road Builder." It is specially designed for road construction and maintenance. The chassis embodies the company's usual construction—including a short wheelbase of 128 in. The engine is in front of the driver's seat. The front wheels have wide center rims, and the rear wheels have detachable herringbone cleats. A spring-type drawbar is used for trailer service, and a rigid drawbar for pulling plows, graders and scrapers. The body has a capacity of 5 cu.yd., or 6 tons, and is made of steel reinforced with heavy gusset plates. It is supported on two 4-in. I-beams, running lengthwise, and connected by five 4-in. I-beam cross-sills. The body is 10 ft. long, 24 in. deep, 6 ft. wide at the front and 6½ ft. wide at the rear end. The tailgate opening can be regulated for the spreading of material in transit. The front end of the body is lifted by a hydraulic hoist with an automatic cut-out at the end of the travel. Lifting is controlled from the driver's seat. A four-cylinder engine drives a jackshaft through a worm gear. On the outer ends of the jackshaft are sprockets for chains to the rear wheels. The transmission has four speeds forward and one reverse. The fourth speed is a direct drive.



MOTOR TRUCK FOR ROAD WORK

Motor-Truck Winch

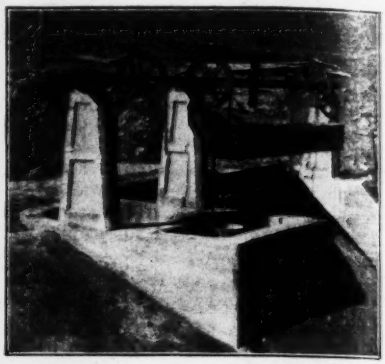
A vertical-shaft winch, for motor trucks with platform bodies, has been developed by the Mead-Morrison Manufacturing Co., of East Boston, Mass. As illustrated, a bedplate supports an 8 x 11-in. head and shaft and a short driveshaft on which is a worm gear meshing with the gear wheel of the drum. The winch is driven by a chain between the gearshaft and truck take-off shaft and is, of course, controlled through the truck-transmission. The winch is fitted with an automatic brake to prevent backward turning of the head in case of chain breakage, etc. This winch develops a single-line rope pull of 3500 lb. and an inhaul speed of 60 ft. per min. It occupies a 22-in. square floor space and weighs complete 350 lb. It costs $350.

VERTICAL TRUCK WINCH

Automatic Canal Headgate

A light steel headgate equipped with automatic control for maintaining constant level in the canal below is shown in the accompanying view as installed in the Oakdale Irrigation District, California. The gate is the "Calco Radial," and the control is the "Meikle," both built by the California Corrugated Culvert Co., of Los Angeles.

A countershaft in roller bearings extends across the gate walls. A pair of chains from the lifting gates pass through sheaves to a counterweight. Beside the canal are two chambers. The downstream one has a small opening connecting with the canal. Between this and the upstream chamber is another opening; but the flow of water is through a telescopic overflow pipe, the height of which can be readily set. In the upstream chamber floats a weighted bucket with a chain going over a third sheave on the countershaft. The upstream chamber has a small discharge outlet, so that a continuous flow is maintained through both chambers. If the water level in the canal falls, the level in the bucket chamber falls also, and the weight of the bucket lifts the headgate so that a larger flow into the canal is permitted. A rising level in the canal operates in the reverse manner to shut off the supply.



LIGHT HEADGATE WITH AUTOMATIC CONTROL

Mounted Drafting Board

A new adjustable drafting board, shown in the accompanying view, has been designed by the Improved Drafting Board Co., of Nashua, N. H. The board is of soft pine, is adjustable as to height and may be set at any angle from horizontal to vertical. Drawings up to 28 x 40 in. are accommodated. The frame is of white-enameled iron, and the balancing weights for the board are concealed inside the frame tubes.

MOUNTED DRAFTING BOARD